

A BEHAVIORAL APPROACH TO WATER RESOURCE MANAGEMENT

BY

ROY BURKE III

A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1974

There is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things. For the reformer has enemies in all who profit by the old order, and only luke-warm defenders in all those who would profit by the new order. This luke-warmness arises partly from fear of their adversaries, who have the law in their favor; and partly from the incredulity of mankind, who do not truly believe in anything new until they have had actual experience of it.

MACHIAVELLI, *The Prince* (1513)

ACKNOWLEDGMENTS

This research would not have been possible without financial support from the EPA Research Fellowship Program and NSF Research Grant GK-30829. Their generous, patient support has made possible the kinds of exploration required for this study.

I wish to thank the members of my advisory committee, Dr. E. E. Pyatt, Dr. J. P. Heaney, Dr. K. C. Gibbs, and Dr. W. A. Rosenbaum. Dr. Gibbs deserves special mention for his select comments throughout the course of this study. My deepest appreciation is extended to each committee member and in particular to Dr. Pyatt and Dr. Heaney who were primarily responsible for the year-to-year progress of my entire program. This dissertation topic did not contain typical precisely defined objectives, and so I am grateful for their patience in providing the luxury to explore for an extended time period. Their willingness to accept an unconventional line of research and their withholding of pressure to produce and publish was taken by me as a vote of confidence in my capabilities. This implied support and vote of confidence provided continual encouragement throughout this long and very difficult research effort. To them and for this, I will forever be grateful.

John McLaughlin, a fellow graduate student, deserves special mention. During some very dark periods, his keen insights, rapid assimilation of a bulk of diverse literature, good humor, and sensitivity

to the difficulty and rightness of this research, provided the encouragement and inspiration for my personal struggle to continue. Peter Daley, although concentrating in another field of graduate study, also deserves special acknowledgment. His high degree of professionalism, vast expertise, outspoken criticism, generous encouragement, and all around good company contributed much to any success which can be claimed during the last two years of work. To them both I am forever grateful.

Even though I deviated often from the most immediate objective of this Ph.D. effort--graduation--I am indebted to the stream of fellow students who continually, and often harshly, reminded me of this first-order objective in the Ph.D. game. These very close associates are too numerous to mention individually; however, they will be forever remembered for their contribution to this effort.

Lastly, I wish to pay tribute to several learned men whom I have met primarily through the published literature. Hoping not to sound presumptuous, I owe a debt of gratitude to these individuals whose efforts have been a major force in shaping my perspectives reflected in this research. These men in alphabetical order are James S. Coleman, Yehezkel Dror, Amitai Etzioni, John Friedmann, Edwin T. Haefele, William K. Linvill, Vincent Ostrom, Hasan Ozbekhan, Anatol Rapoport, and Gilbert S. White. Although their influences are ever present, these individuals cannot be associated with the ways in which their inspiring publications may have been abused, misinterpreted, or misused during the course of this research.

PREFACE

Few exercises produce so quick and deep a glaze in the eyes . . . as the hair-splitting and logic-chopping of conceptualization. Yet some degree of conceptual clarity is essential for the most elementary communication, and the greater the confusion over concept in any field, the less likely is any substantial improvement in knowledge.

--Austin Ranney [1968, p. 6]

Evolution of Research Theme

Most research efforts in technical fields like environmental engineering are guided by pre-specified and operationally defined objectives. Investigation usually advances by measured steps which are specifically designed to satisfy the requirements of each objective.

This research grew from a similar problem oriented point of view. Floodplain management, a traditional activity for water resources engineers, was selected in the beginning as the focal point for investigation. In this context, the problem was defined as the "optimization and application of structural and non-structural flood management alternatives." Mechanically, with very little reflection, I proposed the application of one or more of the optimization techniques from operations research to the accepted list of methods for floodplain management. In this sense, the problem was to be molded around a set of techniques which were attracting considerable professional attention

at that time. (Observers have satirized this type of myopic approach as viewing one's own expertise as a hammer and every problem as a nail.)

Because of the popularity of systems analysis and operations research during the 1960s, especially in connection with highly visible Federal activities, a literature review easily uncovered numerous examples similar to my own proposal. However, analysts reported a limited amount of successful application and in some cases even colossal failure [Friedmann, 1971]. This realization should have come with little surprise since Weinwurm [1957] and Simon and Newell [1958], among others, had earlier issued warnings which qualified the application of operations research to "ill-defined" problems. Thus, during the early stages of this research I began to develop serious reservations about the original proposal. These reservations focused not on one's ability to apply O. R. to floodplain management but on the prospects of finding a meaningful solution from that exercise. Webber [1965, p. 291] captures the essence of this difficulty by observing that, "they [systems techniques] call for a measure of goal consensus, a quality of prediction, a hierarchy of command, and a degree of control that do not exist in the normal context of public affairs."

This type of evidence pointed to the existence of certain basic problem elements which could not be understood, and possibly not even addressed, by my proposed approach. Instead, there seemed to exist very influential and insidious forces which water resource managers systematically ignore. However, to investigate these forces would have required that I step outside the protective nest of more precisely defined techniques and problems. Protected exercises usually receive a successful rating if

(1) they are reasonably detailed and complex, (2) they incorporate a new or well-publicized wrinkle, and (3) they generate results which reasonably conform to our expectations. There was no evidence to suggest that a divergent approach would produce such clear-cut measures of success. Furthermore, the investigation might have revealed a never ending chain of complexities precluding the type of concise results that could be easily judged. Most certainly, an in-depth study would have involved planning and decision concepts rejected and/or considered useless by many water resource practitioners. Finally, a divergent approach would have eliminated any well-defined research objectives, strategies, and time spans and would have substituted general abstract goals and guidelines. But, to do otherwise would have represented only another attempt to stem the tide of pressing "symptoms" while ignoring the underlying causes of water management difficulties. Thus, with a desire to contribute meaningful insight into the process of water management and with little evidence that this research approach would uncover valid issues, I adopted the following research strategy:

- (1) Define the general water resource management problem at the highest level of abstraction that still preserves the identity of essential subsystems;
- (2) At the same level of abstraction, identify the requirements that define a solution to this problem;
- (3) Specify the real world context for which a solution to the general problem will be sought;
- (4) Construct a planning and decision framework, at the same level of abstraction, which satisfies the general requirements and conforms to the specified real world context;

- (5) Systematically refine the level of abstraction until the framework is sufficiently operational to permit application and evaluation; and
- (6) Demonstrate the application of this framework to a problem which does not require the sacrifice of substantial innovative parts of the methodology just to achieve operationality.

The Meaning of Behavioral in "A Behavioral Approach . . ."

The appearance of the word "behavioral" as a part of this dissertation title occurred at the same time as my commitment to a generalized rather than a problem-focused research theme. Its full meaning has evolved over an extended period along with the gradual solidification of my own thought processes. Although a bit premature, the following remarks attempt to describe the broad implications of "behavioral" as a prelude to an elaboration on the scope and strategy of my research activities. The significance of "behavioral" can be appreciated by considering three overlapping aspects of planning: (1) the individual or group which is the focus of planning, (2) the perspective of the planner, and (3) the process which links the planner to participants in the planning sphere.

If we consider "behavioral" with respect to the participants to be served, there needs to be a *human focus* in water planning. According to Ewing [1969, p. 26], "it is *people* who make planning work. It is for the benefit of *people* that plans and programs are designed in the first place." However, planning and management usually focus on objects as measures of performance while stressing production, profit and efficiency. This leads to a method of management described by Erich Fromm [1970, p. B-701], "*in which people were dealt with as if they were*

things." The following example supplied by Archibald [1970, p. 78]

further illustrates the need for a human focus:

The nature of these problems can be illustrated by the story of a farmer who was one day approached by a young and enthusiastic extension agent, an agricultural whiz kid. The agent was pushing a new technique that was supposed to raise the farmer's output by ten percent. The farmer's response was: "I'm only farming half as well as I know how to right now." For whatever reason, the farmer wasn't interested in the performance gap.

Next, when considering the planner's perspective, "behavioral" describes an *image of man* that becomes a part of the planner's cognition and consequently a part of his planning and decision models. This overlaps the previous charge that people are viewed as things; however, in this image-of-man context the implications are more closely aligned with the decision theoretic meaning. According to Flack and Hill [1970, p. 565], "They [men] do not necessarily respond to particular events in terms of the scientific community's characterization of them." Traditional and current perspectives presume that men respond and decide according to very limited rules of behavior. Man is expected to react only to external stimuli like prices, physical factors, etc. However, all men respond to internal factors, as well, such as values, attitudes, perceptions, emotions, and many others, which often dominate their composite reactions. Edwards [1961], Becker and McClintock [1967], and Rapoport and Wallsten [1972] review recent attempts to describe and predict composite human decision behavior. White [1964, 1966] and Kates [1962], among others, have cast individual and collective behavior within a resource management context. Dallmayr [1970] describes the nature of multidimensional man comprised of *economic man*,

social man, and *political man*; Spier [1971] incorporates this multi-dimensional behavior into a framework for benefit-cost analysis.

These types of developments appear to serve notice on contemporary planning perspectives and to offer promise for broadening the behavioral component of water management activities.

Finally, "behavioral" relates to the linkage between participants, on one hand, and planning perspectives on the other. Planning and management require an *action focus* to provide that meaningful bridge between plan formulation and implementation activities. In his discussion of the environment as a challenge to modern society Caldwell [1971, p. 14] remarks, "plans must reach a point of action--and this is the conspicuous point of failure in the history of formal planning." Friedmann [1967, p. 240], a planning theorist, interprets this requirement more precisely, "The formulation and implementation of plans are closely interdependent processes, so that the choice of one will in large measure also determine the second." Recently, systems analysts, who might be more closely attuned to the types of problems facing water management, have started to explicitly consider this issue in connection with their analysis of Humanistic Systems or Large Scale Societal Systems [Linvill, 1972; Malone, 1972a, 1972b]. Thus, by expanding to include societal action and problems of implementation, the analysis must begin to incorporate certain aspects of societal decision making. According to Etzioni [1968] these would include value dynamics and the application of (social) power, in addition to the application of technical knowledge. Thus, in this sense, "behavioral" suggests a reorientation of planning from the passive application of existing knowledge to include power interactions in a climate of collective decision making.

Characteristics and Scope of This Research

This research leans more heavily toward the organization of concepts and theories than toward the solution of specific pressing problems. As such, my research progressed through a gradual solidification and refinement of concepts from various disciplines as they might apply to water management. To keep these concepts in line, I gave high priority to feedback from water resource practitioners using discussions, meetings, and the preparation of several papers [Burke *et al.*, 1972a,b,c]. Comments were varied as might be expected; however, when viewed as a whole certain common questions emerged. For example, is this an attempt to specify how things *should* be done or are being done? Will the proposal be used *now* or in the *future*? In other words, how does the research theme fit in the total scheme of things? Because of the complex requirements of the general water management problem, an answer to these questions rose to a position of major importance. The following section will attempt to place these issues in proper perspective and thus to minimize confusion over them. The research will not completely satisfy the day-to-day manager who needs answers now, nor will it comfort the theoretician who attempts to disentangle all complexities. Instead, it represents a systematic attempt to bridge this gap and yet retain meaning for water management operations.

Lewis Froman has provided a convenient outline for characterizing the important components of policy studies [Froman, 1968]. Conforming to his typology will introduce consistency into the following discussion even though certain deviations and modifications were required.

Strategy component. More emphasis is given to the *process* of water management as opposed to its substance or content. In effect the primary question is how things get done, not what kinds of problems are handled.

Historical component. There is little attempt to trace the historical development of current water programs; this information can be found elsewhere [Economic Research Service, 1972]. Historical considerations enter only through a description of the evolving need for this type of study at this point in time.

Normative component. Does the overall study represent a specific value position describing what we should do? The proposal of a specific planning framework (and the implied rejection of alternatives) represents a normative commitment. Also, the survey and evaluation of various normative models for decision making emphasize this component. However, the overall intent is to formulate a general framework as personally value-free as possible, that serves as an organizing mechanism for planning, discussion, research, specific proposals, etc. This is based on the premise that theory is the only reasoned guide to research, and in the absence of theory, inquiry will become unsystematic trial and error.

Descriptive component. This component enters not through an extensive description of real world water management practices but through an emphasis on action, implementation, and other "behavioral" factors. A high priority is attached to the blending of technical activities to human behavior phenomenon and realities of societal action.

Legal component. Unfortunately, this component is not included explicitly into the analysis.

Problem solving versus theory component. This study does not focus on specific pressing water resource engineering problems. However, there is a strong problem focus at a higher level of generality. New theories are not developed; instead, existing theories which cross-cut various disciplines are assembled to meet general problem requirements. Thus, the overall intent is not to develop new theory but to systematically assemble existing concepts to accomplish a given purpose. In a sense, this may be viewed as new theory since the composite framework is innovative and suggests important testable hypotheses. However, the primary effort focuses on solving the general water management problem defined at a level of generality exceeding most engineering research. For this reason, a specific case study does not serve as the nucleus for concept development, since it would discourage a generalized perspective. However, a test area is used to illustrate the results.

Time horizon component. Consideration of this component usually reveals itself as a hesitation over the immediate application of the proposed framework. Remarks such as, "I have difficulty visualizing how your proposal can be made operational," arose when the research was viewed in this immediate context. Specification of an appropriate time horizon involves two considerations:

- (1) Given existing conditions, how might the research be used now, and how might it evolve in the future? and
- (2) Given that we operate by the proposed framework now, how far into the future will its plans be valid?

The first case will be described in more detail in the chapter containing the specific proposal. However, a certain amount of elaboration will be useful here since the application or operationality of these concepts to a great extent preoccupied most reviewers. As might be expected, a generalized collective decision mechanism will require new types of data, improved programs of public involvement, and modified planning procedures. The fact that these requirements cannot be satisfied today does not make their consideration less critical. But, today, even in the absence of a completely operational proposal, much can be gained by incorporating its principles into planning behavior. Operating within a collective decision atmosphere will begin to redirect planning perspectives and will encourage the introduction of these modified concepts into decision systems to the fullest extent permitted by existing constraints. This specific proposal will also serve as a guidepost to steer modifications and research intended to move planning and decision behavior in a more meaningful direction. And finally, the possibility exists that in future decades water resource programs would be conceived and implemented under ground rules similar to those proposed in this thesis. In fact, the concept of reasonableness was continually applied during the research period to avoid suggesting decision arrangements which were considered unrealistic for American society in decades to come.

The second case materializes after the planning proposal has been established and thus focuses on the future time periods for which emerging plans will be valid. Under new planning proposals will short-run efforts to "put out fires" be given visibility? Or, will the

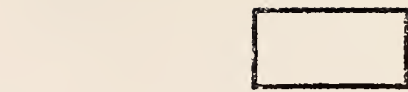
planning focus be shifted from short-run to other time horizons?

Erich Jantsch [1968, p. 20] concisely portrays the nature of this difficulty, "The decision-maker, under high pressure for short-range considerations cannot understand the planner, who is inherently dealing with the long-run future." To help organize our thoughts concerning this problem Platt [1970] identifies three critical future periods of prediction and choice: (1) the *inertia period*, T_i , of 2-10 years in duration in which very little can be done to change the course of events; (2) the *choice period*, T_c , ranging from 10-30 years in which purposive choice can be effective and in which cybernetic or feedback mechanisms begin to dominate; and finally (3) the *uncertainty period*, T_u , which is too far off and too dependent on intervening events to be relevant except in terms of general directions. From this, it seems that purposive action might carry us through 1990 or 2000 but not much further. This does not answer the original question. However, time horizons conceived in this way help to organize our thinking and (for example) cast a new and critical light on the standard Federal time horizon of 50 to 100 years for water projects.

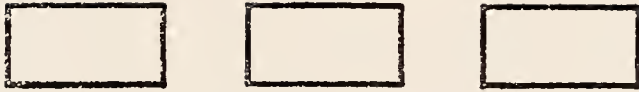
Knowledge organization component. By now it is obvious that various disciplines, levels of concept abstraction, philosophies, etc., have been included in the research effort. To permit a meaningful evaluation and interpretation of specific planning proposals, it becomes critical to identify the manner in which knowledge and fields of study can be organized. In actuality, what disciplines and levels of abstraction are involved? How should they be involved? This question, along with an attempt to define the level of generality, is the most

difficult one to assess and, unfortunately, represents those parts of the conceptual foundation for which satisfactory definitions only partially exist. Some useful guidance is provided by Erich Jantsch [1970] who faces problems similar in nature to those addressed by this study during his effort to reorganize and recategorize university disciplines. According to his terminology, my study would probably be classified as *multidisciplinary*, as compared to *crossdisciplinary*, *interdisciplinary*, etc. An elaboration on these categories can be found in Figure P.1. This research suggests multidisciplinarity since the study includes numerous disciplines with only limited personal cooperation among their representatives.

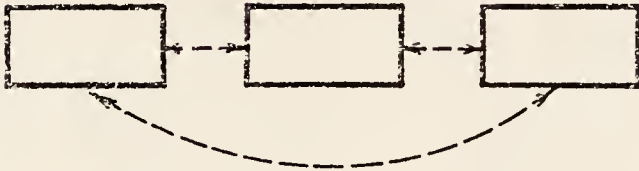
Next, even though personal communication was limited, how should the various concepts and disciplines be organized? How far does this research explore into the fields of knowledge at different levels of abstraction? The organization suggested by Figure P.2 begins to answer these questions. In brief, the pyramid is constructed so that each layer contains the organizing principles for the nearest sublayer. For example, the lowest layer would contain those traditional disciplines which attempt to describe the real world objectively and to interpret observations with logic. The next higher level contains disciplines which would organize concepts from the first sub-level to explain the complex interactions reflected in the real world. The third or normative level begins to answer questions like, "to what end?" by focusing concepts from below. And finally, all disciplines would feed into the highest level of organization which attempts to incorporate ethical and value concepts into knowledge emerging from lower levels.



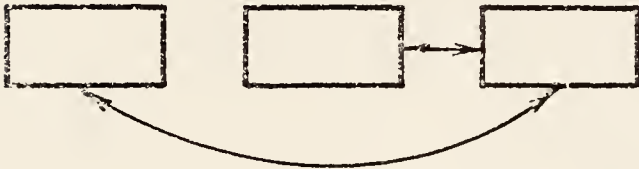
DISCIPLINARITY:
isolated specialties



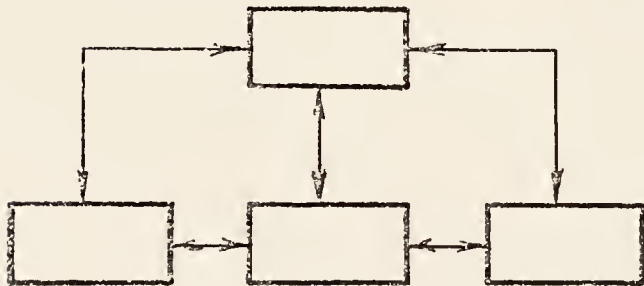
MULTIDISCIPLINARITY:
no cooperation



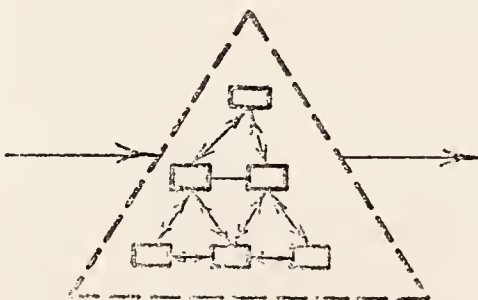
PLURIDISCIPLINARITY:
cooperation without coordination



CROSSDISCIPLINARITY:
polarization toward a monodisciplinary concept



INTERDISCIPLINARITY:
coordination at a higher level



TRANSDISCIPLINARITY:
multilevel coordination of entire system of concepts

Figure P.1. Hierarchy of Modes for Discipline Interaction
(Adapted from Jantsch, 1970)

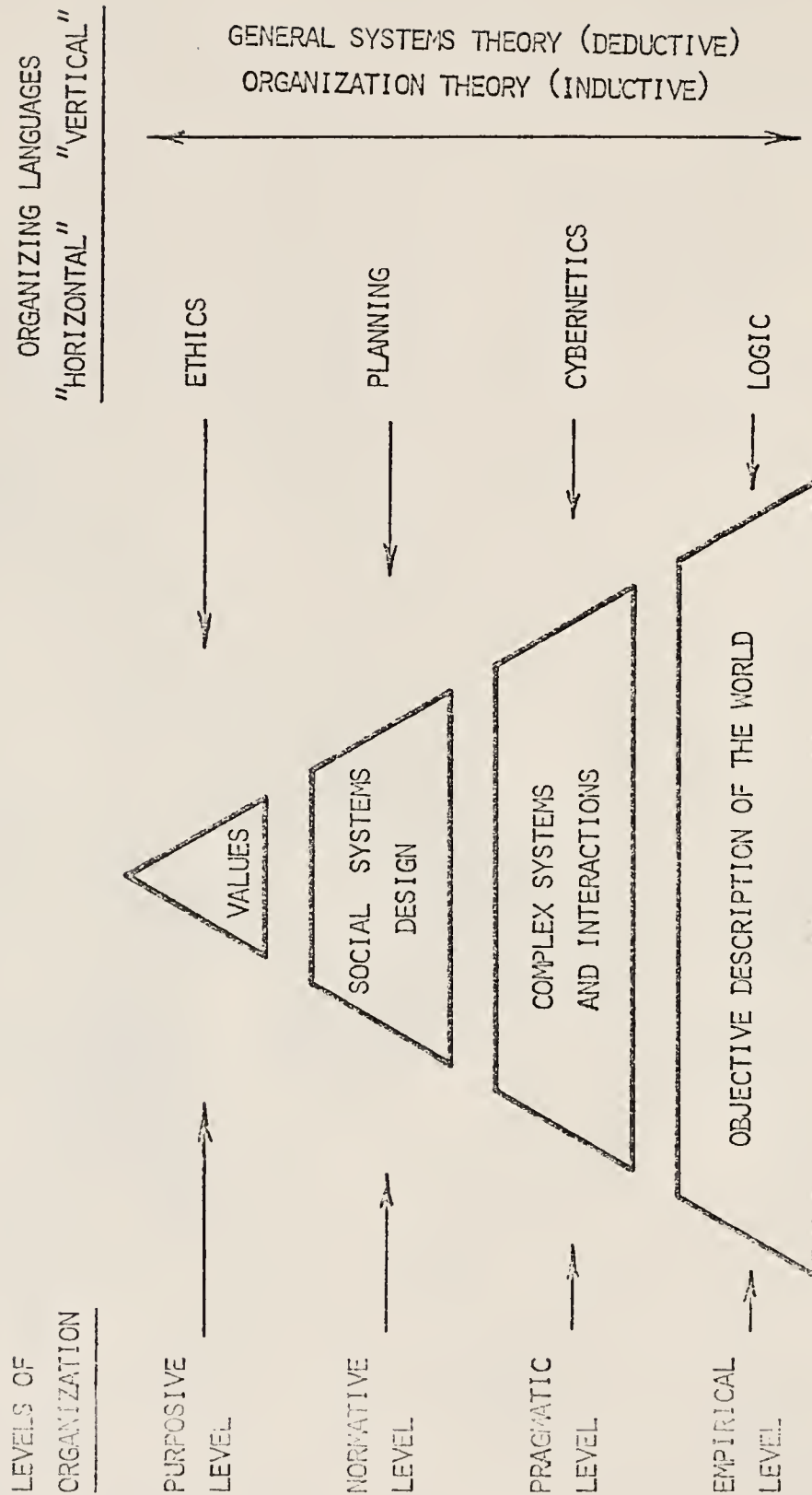


Figure P.2. Levels of Organization for Concepts and Disciplines
(Adapted from Jantsch, 1970)

The point to be made here is that typical water planning studies, especially those which claim to produce "optimum" solutions, stop or sign-off at some intermediate point in their upward progression. Except in rare cases, all planning techniques constrain their exploration to conceptual areas somewhere below the midnormative level with a remark such as "final plan selection will be left for the political process." I am also suggesting that influences which flow into the water management process from beyond this sign-off point have been the dominant influences in planning failure.

The following research does not permit this type of sign-off but encourages the incorporation of value resolution activities into all lower levels. This does not mean that all disciplines are completely explored, reduced to a common denominator, and incorporated into this thesis. However, as a beginning, the research is structured to enhance the vertical organization of these concepts as they might relate to water management. Using the type of structure depicted in Figure P.2, numerous implications emerge; for example, the issue of value resolution appears as a higher order problem subsuming lower level technical problems, which currently seem to preoccupy (and legitimately so) water management practitioners.

Generality component. There is some overlap between this and the preceding component. However, when considering the specific focus and applicability of this research, the intended level of generality became a dominant component in itself and a source of occasional misunderstanding. What has been generalized? To what end? In what manner? To keep this component separate from the

organization of knowledge, generality will apply to the effort to make the research generally applicable, whereas levels of concept organization attempt to establish a hierarchy among traditional fields of knowledge.

A satisfactory definition of generality does not as yet exist. However, insights can be provided following a systems approach which requires first that boundaries be drawn around the system under study. For this study, boundaries were drawn around the total water resource planning and decision system at a level that would not lump the water management theoretician and practitioner into indistinguishable subsystems. This delineation along with a definition of the general water resource decision problem should become clearer as each of the following chapters unfold.

Some Personal Components

This section should be viewed as a continuation of the preceding discussion; however, the focus shifts to those research characteristics which depend strongly on my personal perceptions and biases. Supposedly, the other components could be identified and described using more objective analysis. Those to follow resemble more closely the semiconscious premises which pervade the overall research effort and are more difficult to identify. My affinity for theory as the basis of reasoned research would fall into this category and was described as the steering mechanism for the previous section. Other components of this type include (1) my position concerning the nature of the

collective unit to be studied, (2) my perspective as investigator or the presumed analyst-client relationship, and (3) my personal biases.

First, Buchanan and Tullock [1962, p. 11] state, "A theory of collective choice must be grounded on some assumption concerning the nature of the collective unit." Recognizing the tendency of investigators to overlook this problem, Etzioni [1968, p. 61] emphasizes, "Although the users of various . . . [assumptions] are not necessarily aware of or motivated by them, the differences in approach have significant ideological implication." These remarks are directed at the atomistic vs organismic conceptions of collective activity. Should the water resource system be viewed as a collection of individual, independent actors? In this case, any given macro-characteristic or state-of-society represents a residual flowing from individual actions, and the "general will" or "public interest" would be meaningless. At the other extreme, does society have a mind, identity, and gestalt of its own, independent of the characteristics and activities of various subunits? Under this perspective, the activities of water resource management would take on different characteristics and implications.

My perspective for this research has almost split the difference. Unmistakably, atomistic characteristics have been firmly embedded in the water management problem by way of laissez faire, economic theory, and the philosophy of private enterprise surrounding water resource development. Yet, for this same problem there is an undeniable organismic component. Values, societal properties, bureaucracies, pollution, and other factors seem to have a mind of their own and appear

unresponsive to any pressure for redirection. Also, a concept such as "the public interest," although difficult to define, seems to occupy a substantial position in water resource evaluations. Moreover, even if the preceding statement is not valid according to some higher natural law, such organismic phenomena are *perceived* to exist to the extent that their influence on water resource management will be strongly felt.

The position taken in this study corresponds to Etzioni's [1968] *language of societal action*. In his view, there is a certain amount of stickiness among societal units such that no unit can move significantly without the movement of others. To this somewhat passive condition Etzioni add the concept of mechanisms that are able to guide macroscopic processes and changes. And finally, he introduces power interactions into the societal calculus, among other things, to correct for the balance-of-power conditions inherent in atomistic approaches. This type of foundation encourages a more flexible approach to the general water resource management problem by accounting for a wider variety of factors which exert critical influence. In contrast, the traditional emphasis on atomistic perspectives alone, relying on some invisible force or hidden hand for guidance, has discouraged the introduction of other broader concepts into planning behavior.

The second personal component concerns my perception of the client served by this research and my relationship to him. If society as a whole is the client, (1) I might stand back as an "omniscient observer" protecting their overall best interest or (2) I might become involved in reconciling specific conflicts. Ostrom [1968, 1972b]

identifies the dangers inherent in the omniscient perspective, a perspective which might be implied by the high level of generality in this research problem. However, the primary focus of this study is the agency or organization responsible for translating social needs into some type of plan for satisfying these needs. This establishes the planning agency (team) as the client but does not specify the type of analyst-client relationship followed.

Archibald [1970] provides an excellent analysis of three possible relationships and shows that research recommendations differ significantly depending on the analyst's perspective. Thus, it is very likely that recommendations from this study will reflect the type of analyst-client relationship assumed. An adaptation of Archibald's work appears in Table P.1 as a comparison among a systems approach, incrementalist approach, and clinical approach. It would be unrealistic to place my perspective into any single category. However, if local interest groups are considered in concept to be a part of the client (although loosely attached), then the clinical approach best represents the position taken by this research. Decision making is viewed as participatory at most vertical levels, and great emphasis is placed on rising above those bureaucracy-type constraints on effective action. In Archibald's words, "the client is seen . . . as a social system which because of its complexity has difficulties living up to its full potential" [Archibald, 1970, p. 81].

The third and last personal component is a partial listing of my personal biases:

TABLE P.1. COMPARISON OF 3 ANALYST-CLIENT RELATIONSHIPS
(Adapted from Archibald, 1970)

DISTINGUISHING CHARACTERISTICS	SYSTEMS APPROACH	INCREMENTALIST APPROACH	CLINICAL APPROACH
POSITION OF ANALYST	<i>near top of organization</i>	<i>inside and outside</i>	<i>at all levels</i>
RECOMMENDED DECISION STRUCTURE	<i>centralized</i>	<i>decentralized</i>	<i>participatory</i>
ROLE OF ANALYST	<i>improve decision making in the "public interest"</i>	<i>represent partisan interest</i>	<i>help agency to change and meet problems</i>
PRIMARY CRITERIA	<i>efficiency</i>	<i>political feasibility</i>	<i>acceptability and equity</i>
IF RECOMMENDATIONS DO NOT WORK	<i>client is narrow minded; bureau- cratic resistance</i>	<i>not that important</i>	<i>analyst did poor job of handling complexities</i>

- (1) The *Psychology of More* [Looft, 1971] and the philosophy that "Can" Implies "Ought" [Ozbekhan, 1968] have been major contributions to water resource problems; ✓
- (2) Subjective and human factors constitute the essence of water resource evaluations, thus a focus on objectivity is not only impossible but inappropriate;
- (3) If left to themselves technical analysts will systematically relegate subjective and human factors to an impotent and inoperative status in water program analyses;
- (4) Those who favor protection of the natural system, as their first priority, should have at least equal influence in planning and decision making as those who relegate this to some lower level of priority.

These components in perspective. Depending on one's orientation, the foregoing discussions would be perceived either as so much boilerplate or as an essential exercise. My personal opinion follows closely that of Ozbekhan [1968a, p. 212], "One of the major causes of our failure to plan is that the human mind apparently finds it almost impossible to plan without a conceptual and philosophical framework made up of integrative principles." Furthermore, "Whenever this point is mentioned, the difficulties surrounding that undertaking . . . become crystal clear. . . . In such a theory is one to deal with facts or with goals, with the present or with the future? Are we concerned with continuity or with new departures? Should one write for planners or policy makers?"

To me, a theory or statement of theory is the only reasoned guide to research and planning; without it our efforts tend to be random and arbitrary. Assuming on my part this kind of perspective provokes the same types of questions and misunderstandings described above by Ozbekhan. This Preface, then, attempts to answer anticipated

questions and to establish reasonable ground rules from the very beginning. The following chapters should be judged in this light.

A Brief Preview

Unlike many water resource management studies, this thesis probes into a wide variety of subject areas at one time, including planning, sociology, political science, behavioral science, management and decision science, along with several others. Needless to say, a broad coverage like this makes it impossible to study in great detail any single area. However, this is in keeping with my general intentions throughout the course of study. I view this thesis as an attempt to build bridges between water resource management (as an area of study) and those disciplines, habitually ignored, which have valuable contributions to make in the effort to unify our approach to the water management problem. The study of water resource problems currently enjoys great popularity, but without the benefit of a supporting, integrating framework or a broadly based theoretical foundation which it can call its own. Reductionism pervades most efforts; attention is usually focused on detailed study of small portions of the total problem without a cohesive, unified approach. To counterbalance this tendency, my perspective is holistic rather than reductionist. My intentions are to introduce concepts from other fields of study that serve to unify the loosely held pieces of water resource management.

The reductionist dilemma can be traced to the predominance of so-called analytic thinking in science [Rapoport and Horvath, 1959]. Here, the analyst attempts to understand complexity by examining

constituent parts. Since the parts are easier to understand, the implied hope is that we can understand the whole by superimposing the workings of each component. Massive successes of this approach in natural sciences have tremendous seductive powers when analysts turn their attention to problems with substantial behavioral components. Such complex socio-technical problems are characterized by an interconnected complex net of relations and feedback mechanisms. Where some problems can be analyzed as a time-linear chain of events, socio-technical problems cannot. Where some problems can be studied from part to whole, behaviorally dominated problems cannot. Instead, the focus must be from whole to part. We must have an overarching, integrating concept of the whole system before detailed analysis of any given part can become meaningful.

This philosophy guided my overall approach during this research effort and serves to organize material contained in the following chapters. Thus, keeping in mind the need to proceed from whole to parts from larger system to subsystem, the thesis unfolds as a sequence of ever-narrowing circles. Moving from a description of the largest system of consequence to water planning and management, the analysis gradually probes deeper and deeper into sublayers until a specific component of interest is reached. Detailed analysis is then carried out at this sublevel. Not only does this procedure conform to the requirement of moving from whole to part, it also leaves in its wake what I intend to be the beginnings of that overarching, unifying framework mentioned above. Thus, the many pages between this Preface and the point of contact with the more specific problem were not intended to be simply an

introduction. Instead, those intervening developments should be viewed as an attempt to establish a set of organizing concepts which can stand by themselves as well as guide the flow of this thesis.

Before specific chapters are outlined three terms should be introduced, since they form a unifying thread through most of the sections to follow. These are *systems*, *structure*, and *process*. First, a *systems perspective* is employed as a means of viewing and organizing the overall effort. Even though the principles of General Systems Theory [von Bertalanffy, 1968; Boulding, 1956; Laszlo, 1972a, 1972b, 1972c] were not applied with great rigor throughout the analysis, the repeated use of the term "systems" is consistently intended to convey this message. General Systems Theory has great organizational powers and provides a compelling abstraction for unifying diverse parts of the problem, that is, moving from whole to part, in a manner consistent with the previous discussion. Thus, various parts of the thesis are formulated to hang together in this general systems sense, even though the rigor of systems terminology and logic are, for the most part, de-emphasized.

Most problems, especially those viewed as systems, can be further studied in terms of *structure* and *process*. Structure concerns substance and form, or the static configuration of various parts of the problem. Process refers to the manner in which the components of structure interact over time. For example, one might study natural landscape features, biological communities, human communication and decision networks, interest groups, and other examples of structure. But, one must also include process in the analysis to give life and meaning

to any identifiable structure. They might include geological and ecological interactions over time, the types of interactions which take place within the social structure, and so on. Both components of the investigation are required to capture the essential features of most problems, especially socio-technical ones with a substantial behavioral content. Now, using the notions of systems, structure, and process the chapters unfold in the following manner.

Chapter I. This chapter introduces the basic problem to be addressed by this research, the *disparity* that exists between the capabilities of existing planning and decision models and the requirements exerted by conditions in the external planning environment. After describing the basic nature of this disparity, a review is presented covering contemporary efforts to deal with the difficulty. This look at both Federal and non-Federal responses provides a feeling for the level of advancement to date and the opportunity to suggest implications and probable developments for the future.

Chapter II. Given the existence of a troublesome disparity along with the requirement to proceed from whole to part, this chapter begins to introduce definitions and to establish concepts which give structure to the larger system, the societal overlayer. Using Parsons' General Theory of Action, an integrating framework is provided within which the water resource management system can be oriented. The remainder of the chapter is devoted to the substance and process components of water management within the solid structure of Parsons' general theory.

Chapter III. Moving from the larger societal overlayer, the next lower system, the planning system, becomes the focus of this chapter. Drawing upon Ozbekhan's General Theory of Planning, it becomes possible to bring forward the most current systems thinking in planning theory to show how water resource planning meshes with the larger system, the societal overlayer. This chapter also provides an integrating construct which relates the separate activities *within* the planning system to its overall functioning and to its relation with larger or crosscutting systems.

Chapter IV. Chapters II and III deal primarily with the *structure* of larger systems, the societal overlayer and planning system. Chapter IV begins to introduce *process* into the analysis as a means of giving life to those broader concepts. By using a process, action, or decisional approach, many of the factors to be studied specifically can be boiled down into a single common denominator, the *decision*. Nine bipolar dimensions are employed to characterize any decision situation, with particular emphasis on the general water resource decision problem. Dominant among all these properties, the general problem was presumed to require a *collective action approach*. Not only does this requirement emerge from the decisional analysis in Chapter IV, but also it conforms to requirements imposed by the overarching constructs from Chapters II and III. That is, the collective action requirement represents the same problem posed by Parsons' *Integrative Subsystem*.

Continuing in this vein, the collective action approach is introduced into the water resource problem by way of a *conceptualized*

arena, a device or vehicle which gives visibility and meaning to integrative factors. Along with the arena, I provide a number of criteria for judging its performance, selecting decision rules, assessing its internal processes, and so on. The chapter concludes with a survey of available collective action models divided into normative and behavioral categories.

Chapter V. Extending what was learned from the collective action approach, this chapter describes the application of a single technique, simulation, to a controlled water resource management problem. The water quality problem in Bow River Valley is reassessed in light of prevailing interest group interactions. Results from this approach are compared with findings of several investigators who have studied Bow Valley with other techniques.

Chapter VI. The collective action approach is again extended, this time to an uncontrolled real-world problem. In this instance, the St. Johns River Basin, Florida, provided the issues around which an exploration of integrative factors could be made. A range of diverse techniques for comparative purposes do not exist as they did for Bow River Valley. Moreover, time and data limitations constrained efforts to generate a full-blown case study. But, these are the types of problems which must be experienced if the collective action approach is to achieve a more balanced status.

References cited. Finally, an extensive list of references is provided. This list exceeds in length that which would satisfy the thesis requirements by themselves. However, much of this material is new to the problem of water resource management. Thus, much effort

was expended to develop a balanced reading list for practitioners in the field of water management. In addition to serving the purposes of this report, then, the reference listing should be viewed as a source book of nontechnical information to be used by more technically oriented practitioners. The body of this thesis serves to illustrate the various implications of this set of references for the overall water problem.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	iii
PREFACE	v
Evolution of Research Theme	v
The Meaning of Behavioral in "A Behavioral Approach"	viii
Characteristics and Scope of This Research	xi
Some Personal Components	xx
A Brief Preview	xxvi
LIST OF TABLES	xxxvi
LIST OF FIGURES	xxxviii
ABSTRACT	xli
CHAPTER I THE CHANGING SOCIETAL CONTEXT	1
The Water Management Syndrome	1
Source of the General Outcry	3
Contemporary Responses to the Water Management Syndrome .	8
Federal Responses	10
Non-Federal Responses	14
The Chapter in Perspective	20
CHAPTER II SOME ORGANIZING CONCEPTS	23
To What End?	23
A Systems Perspective	24
The Social System	26
Mechanisms of Social Cohesion (Integration) . .	28
An Expanded Model of Man	32
The General Theory of Action	39
The Water Resource Management System	50
The Planning and Decision Subsystem	65
The Chapter in Perspective	76
CHAPTER III PLANNING THEORY AND WATER RESOURCES MANAGEMENT	79
Introduction	79
Planning as a Universal Concept	80

TABLE OF CONTENTS (Continued)

	Page
CHAPTER III (Continued)	
Planning as a General Concept	82
Planning as a Specific Concept	87
Policy Choice vs Design Choice	87
The Language of Planning	88
Hierarchy of Planning Tasks	91
The "Linkage" Between (S) and (E)	96
CHAPTER IV THEORIES OF DECISION MAKING AND WATER RESOURCES MANAGEMENT	
	100
To Establish a Linkage	100
The Decision	107
Evaluate the Decision Environment	110
Components of the General Water Resource Decision Problem	113
Meeting the Requirements	127
The Collective Action Approach	128
A Conceptualized Arena	130
Criteria for Assessing Arena Performance	141
Decision Costs: When to Stop the Search	147
Summary of "Meeting the Requirements"	153
Criteria for Analysis of Collective Action Models	154
Equity and "The Public Interest"	161
A Survey of Collective Action Models	168
Power	170
A Classification of Models by Their Approach to Power	174
Models of Collective Action With Normative Tendencies	181
Models of Collective Action With Behavioral Tendencies	221
A Summary of Collective Action Models	253
CHAPTER V EXPLORATION OF A CONTROLLED ENVIRONMENT	
	261
Testing the Waters	261
Bow River Valley	262
An Analytical Structure	265
The Local Collective Action "Structure"	270

TABLE OF CONTENTS (Continued)

	Page
CHAPTER V (Continued)	
Introducing Collective Action Analyses	274
Bow Valley CASM	279
Sample Results from CASM	291
Bow Valley from Other Perspectives	312
Dorfman and Jacoby [1969, 1971]	313
Edwin T. Haefele [1971a]	317
Douglas A. Haith [1971]	318
David E. Monarchi [1972]	321
Findings from This Initial Exploration	323
CHAPTER VI EXPLORATION OF A REAL-WORLD ENVIRONMENT	325
A Prolegomena	325
Introduction of Collective Action Analysis	339
Identification of Decision Participants	339
Generation of Data for CASM	348
Findings of Collective Action Analysis	351
A Brief Recap	379
Conclusions, Insights, and Summaries	380
APPENDIX A THE BOW RIVER LINEAR PROGRAMMING MODEL	384
The Technical-Economic Formulation	386
APPENDIX B THE COLLECTIVE ACTION SIMULATION MODEL	394
Illustration of Major CASM Operations	395
To Decide "Yes" or "No"	396
To Select a Leader	397
To Define a Conflict Relationship	399
To Determine the Fate of a Given Plan	402
Formulation of an Operational Model	402
Source Program Listing Collective Action Simulation Model, CASM	405
LIST OF REFERENCES	442
BIOGRAPHICAL SKETCH	484

LIST OF TABLES

Table	Page
P.1 Comparison of 3 Analyst-Client Relationships	xxiv
2.1 Parallels for Multidimensional Man	35
4.1 Typology of Normative Decision Models	111
4.2 Typology of Descriptive Decision Models	112
4.3 Probability That a Given Voter Will Lose on Any Given Vote, in the Long Run	190
4.4 Model of the Community Decision-Making Process	232
4.5 Summary of Conditions Associated With Successful Conflict Resolution and Consensus	236
5.1 A Selection of Possible Bow Valley Plans	266
5.2 A Summary of "Scaled" Bow Valley Plans	282
5.3 Goals Structure for Each Group Under "Soft Line" Positions	284
5.4 Goals Structure for Each Group Under "Hard Line" Positions	285
5.5 Ideological Position of Each Group Toward Each Project Component	286
5.6 Inventory of Power Resources for Each Group	287
5.7 Social Power of Bow Valley Decision Participants	288
5.8 Most Important Project Component for Each Group	288
6.1 Brief Description of Alternative Plans Considered for the Upper St. Johns River Basin	338
6.2 Issue Salience Ranking for Each Participant	352
6.3 Power Coefficients for Each Participant	352
6.4 Ideological Position of Each Group Toward Each Project Component	353
6.5 Goals Structure for Each Group Under "Soft Line" Positions	354

LIST OF TABLES (Continued)

Table		Page
6.6	Goals Structure for Each Group Under "Hard Line" Positions	355
6.7	A Summary of "Scaled" St. Johns Plans	356
6.8	Probability of Success for Each St. Johns Plan Under Various CASM Conditions	358
6.9	Probability of a Tie or Stalemate for Each St. Johns Plan Under Various CASM Conditions	359
6.10	Probability of Defeat for Each St. Johns Plan Under Various CASM Conditions	360
6.11	A Ranking and Leadership Summary for the Upper St. Johns "Basic Six"	378
A.1	Treatment Cost Data for Bow River, c_{ik}	388
A.2	Benefit Data for Bow River; $bf_{ij,1}$ and $bf_{ij,2}$ (\$ per year per unit increase in D. O.)	389
A.3	D.O. Transport Coefficients for Bow River t_{ij} , mg/l per lb/day	391

LIST OF FIGURES

Figure		Page
P.1	Hierarchy of Modes for Discipline Interaction	xvii
P.2	Levels of Organization for Concepts and Disciplines . . .	xviii
2.1	Multidimensional Human Behavior as a Function of "Need-Resource" Pairs	37
2.2	A General Theory of Action	43
2.3	Subsystems for Coordinating Double Boundary Exchanges . .	46
2.4	Interaction Between Parsons' Polity and Integrative Subsystem	47
2.5	Definition of a "System"	52
2.6	Society and the Water Resource Management Subsystem . . .	54
2.7	The WRM Subsystem in Systems-Logic Form	56
2.8	The Planning and Decision Subsystem Expanded in Systems-Logic Form	57
2.9	A Three-Dimensional Model for Assessing Leverage Points .	60
2.10	Water Resource Planning and Decision Hierarchy	67
2.11	The Water Planning and Decision Subsystem Represented as Interactions Between Parsons' "Polity" and "Integrative Subsystems"	69
2.12	Influence of Time in the Social Decision Process	75
2.13	Components of the Conjoint Planning Process	77
3.1	Hierarchy of Systems	85
3.2	Planning's Hierarchical Subsystems	90
3.3	Conjoint Planning and the Task Hierarchy	93
3.4	Pivotal Role of the Decision-Making Processes	98

LIST OF FIGURES (Continued)

Figure	Page
4.1 Two-Way Classification for Decision Analysis	103
4.2 Trajectory of the Conjoint Planning Process	137
4.3 Inherent Costs of Collective Decision Making	151
4.4 The Administrative Policy Formation Grid and the "Public Interest"	167
4.5 Probability That a Given Individual Will Lose on Any Given Vote, in the Long Run	190
4.6 Model for Coalition Formation Where Potential Members Share Attitudinal and/or Ideological Positions	205
4.7 Effect of Social Power on Opinion Change	213
4.8 Effect of Group Structure on Social Choice Outcome . . .	214
4.9 Example Sociogram and Its Matrix Representations . . .	239
4.10 Two-Way Typology to Aid the Models' Summary	258
5.1 Schematic Diagram of Bow River Valley	264
5.2 A Partial Goals Hierarchy for Bow Valley	271
5.3 A Full Goals Hierarchy for Bow Valley	272
5.4 Logic of Bow Valley Collective Action Analysis	278
5.5 Page 1 of CASM Output for a Typical Plan	292
5.6 Page 2 of CASM Output for a Typical Plan	293
5.7 The Shift in Conflict Over a Range of Bow Valley Plans.	296
5.8 Arena Response to Changes in Cooperative Atmospheres .	301
5.9 Influence of the Ability to Consolidate Coalition Effort	304
5.10 Arena Response to the Water Quality Component	307
5.11 Effect of Alternative Decision Rules	310

LIST OF FIGURES (Continued)

Figure		Page
6.1	General Location of the Upper St. Johns River Basin, Florida	326
6.2	Outline of the Upper St. Johns Drainage Basin Divided into 21 Hydrologic Sub-Basins	332
6.3	Outline of Existing Dikes Defining the Extent of Man's Encroachment into the Upper St. Johns Drainage Basin .	333
6.4	Outline of MLRA 156 Defining the Extent of the Natural, Virgin Floodplain in the Upper St. Johns Drainage Basin	334
6.5	Schematic Diagram of the Proposed Corps Project for Water Control in the Upper St. Johns Drainage Basin . .	335
6.6	Property Outlines of Land Holdings, of More Than 5000 Acres, Which Extend into the Upper St. Johns Drainage Basin	337
6.7	Arena Response to St. Johns Issues, Numbers (1) Through (4)	367
6.8	Arena Response to St. Johns Issues, Numbers (5) Through (8)	368
6.9	Tradeoff Between Selected St. Johns Issues, in Terms of Arena Responses	369
A.1	A Schematic Diagram of the Bow River Problem	385
A.2	Linear Programming Formulation for Bow River	393
B.1	Pattern of Deliberation for Each Group Considering Three Separate Issues	398

Abstract of Dissertation Presented to the Graduate Council
of the University of Florida in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

A BEHAVIORAL APPROACH TO WATER RESOURCE MANAGEMENT

By

Roy Burke III

June, 1974

Chairman: Dr. Edwin E. Pyatt

Co-Chairman: Dr. James P. Heaney

Major Department: Environmental Engineering Sciences

Water resource management spans all of those water-related events from initial awareness of needs to final implementation of water-related activities. The current sense of floundering and frustration relative to this management cycle can be attributed to inadequate planning approaches and techniques which have not kept pace with evolving requirements.

According to the current status of planning thought, this disparity between capabilities and requirements can be addressed by providing a *"linkage" between scientific technical intelligence and organized societal action*. To identify the proper linkage one may start with the larger social system and attempt to identify the key mechanism; or, the analysis can begin at the lowest level of functional planning subsystems and move upward to define the appropriate link. Using Parsons' *General Theory of Action* and Ozbekhan's *General Theory of Planning* as the beginning point for each strategy, the same phenomenon is identified as the proper linking mechanism and, thus,

as the most sensitive place to begin the study of water resource management difficulties. The *decision* and the *decision making process*, in all its complex forms, can be used as the common denominator or common unit of analysis. Each problem can be identified by the manner in which decisional requirements are not met; each recommended solution can be cast in terms of proper decision and model specifications.

By viewing water resource management from this decisional perspective, one can identify several fundamental problem components which must be addressed explicitly:

- (1) *Complexity*. The problem is characterized by complexity and complex interactions. Our lack of ability to handle complexity (a) forces us to simplify the problem until our solutions are unrepresentative, (b) creates intangible factors and external effects which disrupt solutions, and (c) forces decision making to higher levels away from responsiveness to local conditions.
- (2) *Collective action and collective resources*. Water management requires a collective decision process for resources which are collectively owned. Current practices often proceed as if the opposite were true.
- (3) *Normative content*. Value dynamics is the first-order consideration in water management, and thus, explicit normative statements are required to describe what "ought" to be done. Current practices deliver very restricted normative commitments and therefore need adjustment by behavioral considerations: (a) planning must focus more heavily on people, not things, and their values, preferences, attitudes, opinions, behavior, and so on, (b) plan formulation and program implementation need equal visibility in terms of the social decision process which links them together.

To face these difficulties and to correct for existing inadequacies a *planning-bargaining arena* must be superimposed over planning behavior. This arena might exist as a legitimized decision authority, or it might exist in concept only and thus serve as a guide or organizing mechanism. In either case, the arena would be composed of

interested groups, agency representatives, technical personnel, and others involved in water issues.

In the absence of a formal structure to house this arena, one might superimpose political simulation over technical processes as a means of investigating pertinent variables in the external planning environment. A planning agency might be interested in (1) a social ranking of alternative plans, (2) identifying major issues to be expected, (3) exposing winners and losers relative to proposed plans, (4) revealing the likelihood of acceptance and implementation, (5) investigating the effects of alternative decision rules, and many others. This type of information should enhance the incorporation of many important factors into the planning process, but the probability of making a decision maker's job easier is not very good.

CHAPTER I

THE CHANGING SOCIETAL CONTEXT

Societal decisions that are made in ignorance of the values of the populations affected by the decisions frequently have unexpected results.

--Robin M. Williams, Jr. [1967, p. 28]

The Water Management Syndrome

Contemporary water management practices, which germinated under philosophies of big construction and comprehensive planning, have changed very little over the last 30 years. However, the *societal context* for water planning has changed substantially even to the extent that planning and evaluation procedures themselves have become the focus of water-related conflicts. Thus, it has become necessary, if we expect success in our planning efforts, to investigate the external planning environment and, if possible, to redefine water resources management to conform to these fluid external requirements.

Several recent examples of planning failure can be used to identify this gap which has developed between current planning requirements and the capabilities of traditional water planning approaches. In each case, certain factors, seldom explored during plan formulation, emerged to disrupt and dominate the traditional flow of planning activities.

Lake Washington in Seattle has been a well-publicized example illustrating the importance of the changing external environment on planning effectiveness [Chasan, 1971; Edmondson, 1971]. Here, traditional engineering guidelines led to the diversion of storm runoff into the lake and certain proposed transportation facilities promised to fracture the integrity of the lake's natural setting. Responding to the reality of a dying lake, those local citizens who placed great value on a high quality metropolitan lake reversed this trend and, as a result, confronted local engineering philosophies with new planning criteria.

Next, the Cross-Florida Barge Canal serves to illustrate the importance of considering diverse value systems for meaningful and effective water management. Numerous proposals for this type of water transportation route had been made since 1826, all of which focused on commercial navigation as the primary beneficiary [Fisher, 1971; Hartley, 1971]. Thus, the construction that began in 1964 followed plans which did not reflect other, emerging value systems. Before construction could be halted by opposing forces (actually through a Presidential decision) \$50 million had been spent on canal components. Expenditures of this magnitude, possibly wasted, provide tangible incentives for the investigation of a broader range of factors external to traditional planning systems.

Finally, the Brandywine Creek watershed in Pennsylvania can be used to illustrate the influence of those more subtle factors such as cultural background, attitudes, perceptions, and other behavioral phenomena [Thompson, 1969; Keene and Strong, 1970]. Foreseeing possible

misuse of this unspoiled watershed, a planning group including a variety of disciplines was assembled to develop methods for guiding incipient development. Their management program, now widely acclaimed in regional planning circles [Thompson, 1969], was flatly rejected by local residents who, because of their cultural background, opposed the use of eminent domain.

Thus, we have these and many other examples of planning failure that seem to be inspired by those factors which have traditionally been beyond the planning sphere. Considered together, such instances of planning failure exhibit several common symptoms which might be called the *Water Management Syndrome*:

- (1) Lack of compatibility with the natural system and/or "wise" use of natural resources;
- (2) Actual performance below expected design levels;
- (3) "The public interest" somehow poorly represented; and/or
- (4) Ultimate failure in implementation.

Source of the General Outcry

The increased visibility of this syndrome, in recent years, has generated a sense of frustration among water resource practitioners. According to Ozbekhan [1968a, p. 211], "There is a sense of floundering--a feeling that we don't know exactly where it is we want to end up or that we have not really understood the problems we are trying to solve." Manheim [1972, p. 2] concludes that the traditional model for reaching decisions through objective analysis is no longer *viable* since, "the public no longer believes in the objectivity of the

professional's analysis, and is unwilling to accept his recommendations unquestioningly." This represents a striking change in the external planning environment from the period in which water projects were considered to be a valuable asset. Furthermore, since this phenomenon developed and matured over a very short period of 10 to 15 years in a society that normally transforms very slowly, some very influential forces must be active. Thus, an investigation of the causes and sources of this general outcry should yield valuable information concerning the changing external context with which water managers must contend.

The first and probably most visible cause is a *change in the problem* resulting, in part, from the growth in population and technology. Only a few years ago the physical and social distances between people allowed many adverse effects to be dampened before they ignited serious negative reaction. Now it seems that every action affects every other factor in ways which are often uncomfortable for water resource managers. This, of course, presents a new problem to be faced. It will no longer be sufficient to study only first-order cause and effect relationships. New management techniques must recognize the importance of complex interactions and thus investigate a much expanded list of physical, economic, and social factors and the processes that connect them.

Another reason for the sudden emergence of dissatisfaction can be attributed to an *improved access to the decision making process* for those groups which were previously denied access. The conditions under which incipient groups can be denied access to the political arena can be appreciated in terms of Gamson's model [1968] of *Stable Unrepresentation in American Society*. According to this model, "the American

political system normally operates to prevent incipient competitors from achieving full entry into the political arena" [Gamson, 1968, p. 18]. Thus, although American pluralist democracy reduces the possibility of *dominance* by a single organized group, there is a tendency for the interlocking, powerful groups to be *unresponsive* to unmet or changing needs among the citizenry. This suggests that the earlier lack of public outcry in water management (stability) can be attributed, in part, to an unbalanced access to decision processes (unrepresentation). Furthermore, even if access were improved, an effective organization of large groups would still be extremely difficult unless lobbying activities developed as a by-product of some other commonly shared organizing factor. The individual will not participate otherwise in such groups, "because he knows, first, that his own efforts would not have a noticeable effect, and second, that he would get the benefits . . . that others achieved in any case" [Olson, 1968, p. 166].

But, in the changing societal context, access to the water management decision process seems to have increased. Anticipating this possibility, Gamson also identified the conditions under which "stable unrepresentation" may break down:

- (1) Crises in the achievement of collective goals from, for example, a cumulative inadequacy of government responses to internal needs;
- (2) Efforts toward broader planning, like total cost-effectiveness studies, which may open the arena and lead to greater responsiveness to excluded groups;
- (3) Organization of large groups which secure their constituency around some nonpolitical service and then apply their resources to the political arena; and/or,

- (4) Organization of small pressure groups, around political demands, within which each individual can relate his personal efforts to the advancement of group goals [added to Gamson's original list].

Although they cannot serve as proof, numerous examples can be found for each of these conditions which suggests that stable unrepresentation may be evolving into a more open, pluralistic form. This has important implications for water management techniques which developed in the earlier climate of limited political access. Future planning techniques must be able to cope with this more pluralistic external environment. A well-established clientele will no longer exist; instead, procedures will be required that deal specifically with a range of diverse interests that ebb and flow through local political arenas.

A third cause for the changing context may be described as *societal experience with policy outcomes*. Often, it takes a number of years for physical and social "effects" of various water decisions to become fully revealed. Since societal goals and tradeoff factors do not exist a priori, this continued experience with outcomes of past decisions may offer the best mechanism for revealing social preferences. Morris [1972a] describes human unwillingness to be specific about goals and adds that, "Without experience, without discussion, without objectives dictated by some creed or policy, we are unlikely to know what we want" [Morris, 1972b, p. 42]. Thus, the sudden outcry has reflected, in part, the establishment of more specific social goals and tradeoff factors in response to experience with *actual* losses and gains realized by existing water programs. In itself, this realization is not very startling; however, it does suggest certain characteristics of the external planning environment important to water management. For one

thing, overt responses to decision outcomes can be taken as a more legitimate measure of preference compared to any a priori, arbitrary statement of objectives. Furthermore, if goals have solidified because of past experiences then goals will continue to be established in a similar dynamic fashion. This strongly suggests the need for management techniques with a built-in flexibility specifically designed to cope with the variable and fluid expressions of goals.

Finally, the sudden outcry can be associated with a genuine *shift in social values* [Universities Council on Water Resources, 1971]. Furthermore, Crowe [1969] suggests that the disparity among value systems has increased to the extent that public decisions will no longer represent compromises, but zero-sum conflicts among competing groups with distinct winners and losers. Examples of this all-or-nothing value conflict are plentiful in water management, however, the main concern here focuses on the fact that value system dynamics characterize the external planning environment. Wilson [1969, 1970, 1971] presents results of a study for General Electric which projected the types of value changes to expect in the next 10 years. There should be little difference between this corporate quest for responsiveness and the type of responsiveness to local needs which is sought in water management. Thus, the value changes projected by Wilson provide a useful glimpse into the requirements which must be satisfied by future planning techniques:

- (1) An emphasis on the quality of life, not quantity;
- (2) A belief that leisure is a valid activity in its own right;

- (3) An emphasis on pluralism, decentralization, participation, and involvement;
- (4) A shift from technical efficiency to social equity; and
- (5) A shift from maintenance of status quo toward promotion of change.

This presentation of sources for the "general outcry" was not intended to be exhaustive or surprising. Other works, such as Calwell's [1971] *Environment: A Challenge to Modern Society*, provide comprehensive and thought provoking analyses of these issues. Instead, this listing was constructed to illustrate certain important characteristics of the changing societal context and to identify certain requirements which must be met by future planning procedures. Unfortunately, the water management literature (with exceptions, of course) does not reveal a systematic approach to planning research. True, water resource practitioners live with the external environment and the water management syndrome day after day. However, when new planning techniques are proposed they are more likely to focus on specific problems from the perspective of traditional planning approaches. Little attempt is made to explore the broader societal context of planning activities except to acknowledge that something insidious is "out there."

Contemporary Responses to The Water Management Syndrome

The current pattern of water resource planning originated in the Flood Control Act of 1936 which established benefit-cost analysis as a critical element in the overall decision process. For the next 25 years, modifications in planning procedures focused only on the

technical refinement of benefit-cost analysis and were less concerned with broader changes in planning requirements:

- (1) The *Green Book* [U.S. Interagency Committee on Water Resources, 1950] represented the first government-wide effort to formulate, in economic terms, the philosophy expressed by the Flood Control Act of 1936. This document contained specifications and procedures designed to insure that project analysis conformed to established theories in welfare economics.
- (2) Next, to correct for the fact that each agency interpreted the *Green Book* to fit its separate requirements, *Circular A-47* [U.S. Bureau of the Budget, 1952] attempted to establish a uniform Federal policy for project analysis. This along with other Bureau specifications has the effect of emphasizing national economic efficiency as the primary water resource objective at the expense of other objectives such as environmental protection.
- (3) Congressional dissatisfaction with the lack of flexibility imposed by *Circular A-47* encouraged independent review of existing proceedings [Hufschmidt *et al.*, 1961] and the eventual publication of *Senate Document 97* [U.S. Senate, 1962] which was never actually approved by the Senate. This document, which is still the unwritten rule in Federal water resource planning, was an attempt to make procedures as flexible and robust as possible yet consistent with requirements of economic analysis.

Since this sequence of modifications represents only refinements in the technical deficiencies of cost-benefit analysis, they should not be classified along with more recent attempts to study broader planning requirements. In this regard, *Senate Document 97* can be viewed as the last of the "traditional" guidelines and the termination of an era which emphasized the engineering-economic approach to water resource management. All serious investigations of water planning since *Senate Document 97* have explored beyond these restricted boundaries. Thus, it is unlikely that future "S. D. 97's" will exclude explicit recommendations to meet broader planning requirements. The following review attempts to describe the nature of these explorations which, unfortunately, represent passive responses rather than purposeful efforts to

redefine planning processes. Nevertheless, recent studies in this transition period offer strong suggestions concerning the direction which water planning will take and provide a reference point for concepts appearing in the following chapters.

Federal Responses

For the most part, Federal responses have been directed toward solving specific problems and not toward the vitalization of planning processes in general. Evidence of this is revealed by the proportionally large expenditures for construction and the development of technology. However, in the early 60s the *Water Resources Research Act of 1964* (PL 88-397, as amended) led to the organization of the office of Water Resources Research which provided an outlet for funds applied to diverse research activities. Considering all recent studies that have a broad planning focus OWRR has sponsored only a small proportion. Their primary influence has been expressed through the collection and dissemination of water-related information leading to the recent bibliographies on *Institutional Aspects of Water Resources Development* [WRSIC, 1971] and *Urban Water Planning* [WRSIC, 1972].

In the mid 1960s the Committee on Water of the National Academy of Sciences published an influential pamphlet *Alternatives in Water Management* [NAS/NRC, 1966]. This document spelled out clearly the need for a broader planning focus emphasizing the overall planning process including a human focus, values and value dynamics, alternative futures, equity and the distribution of benefits and costs, intangibles and nonmarketable effects, and so on. Such factors were not mysterious

to water management prior to 1966; however, the Committee on Water established an unequivocal position relative to the external context for planning. This, in a sense severed the possibility of retreat in future efforts from the true requirements of meaningful water management.

Another Federal response to changing requirements emerged from the recommendations of the Senate Select Committee on National Water Resources [U.S. Senate, 1961]. This committee recognized the need for more meaningful coordination among existing water programs, a fact that led to the *Water Resources Planning Act of 1965* (P.L. 89-80, 22 July 1965). Among other actions, this Act established the cabinet-level Water Resources Council which (1) administers grants for state water planning, (2) coordinates river basin planning including river basin commissions established by the Act, and (3) recommends policies and procedures for Federal water resource development programs.

The latter provision represents the Federal response of interest to this review when considering the overall process of water planning. To accomplish this, the Council formed a special task force in November 1968 to develop more responsive procedures for the planning and evaluation of water and related land resources. Their most recent proposal [U.S. Water Resources Council, 1971] begins to reflect, in an explicit manner, certain requirements of the external planning environment, as described in previous paragraphs, in particular the need to consider a broader range of social objectives. Given the earlier Federal emphasis on national economic efficiency as the primary objective, the task force proposal expands the list to include, in addition, the enhancement of (1) regional development, (2) environmental quality, and (3) social

well-being. Furthermore, the proposal makes clear that no single objective should be automatically considered to be the primary objective and that proposed plans should be evaluated in terms of their contributions to the overall set of objectives.

This represents a more intimate association with the changing societal context than had been achieved by earlier engineering-economic guidelines. However, the task force proposal grew out of the philosophy of benefit-cost analysis and, as a result, suffers from similar deficiencies. First, it still represents an aggregate analysis with few provisions to help identify the specific recipients of benefits and costs. Not only does aggregate reporting submerge political implications and the nature of the social decision process, it also impedes an analysis of equity or "who" gets "what." Quite often this type of lumped analysis will justify benefits to a particular clientele group in the name of the overall public good. Second, the specific task force proposals ignore the value dynamics which surround water problems. Their procedure will enhance the explicit consideration of different objectives but does not offer guidelines to assist in the selection of a *single* plan from the set of good available plans. Therefore, the first-order problem, the *resolution of diverse value systems*, still remains.

Further Federal responses to pressures from the external planning environment emerged in the *National Water Commission Act* (P.L. 90-515, 26 September 1968) which, of course, established the National Water Commission. Historically, fact-finding bodies have usually been attached to various coordinated governmental resource

studies [U.S. Senate, 1959]. The most recent example was the so-called "Kerr" Committee [U.S. Senate, 1961] which like many of its predecessors was too closely associated with the ebb and flow of Congressional politics. To avoid this type of difficulty the Johnson administration (had) established the *independent* National Water Commission to conduct the broadest possible exploration into water related issues. Aside from their technical studies, the Commission has investigated intensively the legal aspects of water management, organizational and decision making components [Clyde and Jensen, 1971; Delogu, 1971; Fox, 1971c; Ingram, 1971b; Ostrom, 1971a; Schmid, 1971; Urban Systems, 1971], the problems and expectations of public participation activities [Warner, 1971], environmental quality and aesthetics [Goldman, 1971, Litton, 1971], and planning [Consulting Panel, 1972], among many others. The point to be emphasized here is that, at least on a quasi-Federal level, substantial interest has been allocated to nontechnical components of water management. In later chapters, shortcomings of various studies listed here will be identified, however, the extensive effort by the Commission in this area reveals a certain commitment to factors which have not been considered explicitly in the past.

The last Federal response of interest to this review is contained in the *National Environmental Policy Act of 1969* (P.L. 91-190, 1 January 1970). This legislation established the Council on Environmental Quality within the Office of Science and Technology and, among other things, required that CEQ coordinate the preparation of "environmental statements" on Federal actions significantly affecting the quality of the human environment. Subsequent guidelines issued by CEQ

[Council on Environmental Quality, 1971a,b] represent only procedural modifications in the existing flow of Federal planning activities, not changes in decision making or planning processes. However, it has had the effect of raising the stature and visibility of environmental considerations which may set a precedent for similar emphasis on social and political "effects." Thus, in this sense, N.E.P.A. can be viewed as a legitimate Federal response to the external planning requirements described earlier.

Non-Federal Responses

For several years, various non-Federal individuals and groups, like the American Institute of Planners, have responded to changing planning requirements. Also, there has been considerable interest in the development and application of quantitative "planning" techniques in water management specifically. In the late 1950s, the Harvard Water Program [Maass *et al.*, 1962] sparked an avalanche of efforts to apply systems engineering techniques to water management, which continues today. However, in the context of this review, these cannot be equated with planning; instead, they represent mainly informational mechanisms for the larger planning and decision system. Thus, the following paragraphs will focus on efforts, applied to water management, which reflect the need to consider the broader societal context for "planning."

The Universities Council on Water Resources [1971] seems to be among the first non-Federal practitioners to fully explore the planning realm beyond classical considerations. Their Task Force on Water Resources Evaluation recognizes that the process of water management must be embedded in the overlay of organized societal action and that

traditional evaluation techniques fail to accomplish this. Based on these conclusions, the Task Force outlined a research program to improve evaluation processes that included, among others, the overall planning process, public participation, the role of values and conflict, social indicators, and bargaining mechanisms. Following this, the American Water Resources Association, as professional representative of water practitioners, explored these issues in more detail in an attempt to emphasize this broader planning perspective [Whipple, 1970]. Even traditionally technical organizations such as the American Society of Civil Engineers have started to reassess their roles by redefining environmental engineering and by emphasizing a human focus, socio-technical systems, purposive action, social goals, and so on [ASCE, 1971].

In addition to Federal guidelines and professional society investigations there have been a number of individual research activities which seem to be setting the tone for planning and decision making in the 1970s. As an example, The Technical Committee of the Water Resource Centers of the Thirteen Western States [1971] has initiated a systematic investigation of social goals and their relevance to water planning and management. They attempt to provide a means for evaluating the (expected) performance of water plans using an array of social indicators which can be related to societal goals through a hierarchy of subgoals and objectives. Although social indicators have been studied for possible use in other planning areas (for example, *Toward a Social Report* [U.S. Department of Health, Education, and Welfare, 1969] and *Social Indicators* [Bauer, 1966]), this study represents their debut in water resource management. Even more important, however, is the

implication that water related activities can and should be evaluated systematically in terms of their performance relative to a broad range of social goals and objectives.

In a slightly different context, the four broad objectives proposed by the Water Resources Council [1971] have ignited a flurry of interest in "multiobjective" planning techniques. Here, there seems to be less emphasis on the complex interactions which eventually reveal themselves as movement toward or away from various objectives; instead, the analysis focuses on the critical tradeoffs that may exist between pairs of objectives themselves, and further, the specific tradeoff value that can be called the "best." Most efforts to date, especially Major [1969], Major and Associates [1970], and Miller and Byers [1972, 1973] have identified the tradeoffs that seem to exist between some measure of environmental quality and national economic benefits. Major carries this analysis a step further by defining the specific tradeoff values preferred by the Corps of Engineers and Conservationists in a particular river basin. It is not altogether clear how the final "best" tradeoff would be selected once various preferences have been expressed, i.e., Corps vs Conservationists. However, this type of analysis does open up the evaluation of water programs to the extent that various objectives and diverse social preferences can be explicitly considered and, conversely, cannot be easily ignored.

In recent studies, emphasis has also been placed on participants in the water management system, in contrast to the previous focus on goal dynamics. For example, Bromley *et al.* [1971] provide an elaborate appeal for a display of various groups along with the costs and benefits

accruing to each (for each proposed plan). This, they feel, would be a more substantial contribution to effective decision making, at all levels, compared to other more aggregate analyses. Other investigators [Heaney *et al.*, 1972; Burke *et al.*, 1972a,b,c] carry this type of analysis a step further by suggesting the types of behavior that various groups might display based on the distribution of benefits and costs. Without doubt, such analyses begin to complicate water management procedures. However, they do represent initial steps in the overall attempt to bring a planning into closer harmony with the larger social system.

Further emphasis on participants is reflected by various attempts to involve the public in water management. Citizen action programs of one type or another have been prominent components in other areas such as urban planning for a number of years. Water management programs have lagged in their willingness to introduce public participation activities in the same way that social indicators seem to be receiving less than their share of attention. However, there seems to be a growing commitment to broader based involvement even in the face of initial setbacks in various water-related trial runs. As a matter of policy, the Corps of Engineers has formally established public dialogue and participation as an integral part of their planning process [Institute for Water Resources, 1970]. Dodge [1973] reemphasizes this commitment but points out the difficulties involved in translating broad policy into tractable programs at field level. Two notable exceptions have been documented. First, considerable success was realized in administering a series of workshops during the planning stages of

a Susquehanna River project [Borton *et al.*, 1970], even though difficulty was encountered when introducing participation data into decision making calculations. On the other hand, Sargent [1972] describes a more successful program in the Pacific Northwest at least in the area of information exchange and development of public trust.

To add further fuel to the growing emphasis on involvement, Flack describes a system of computer graphics which was designed to enhance information display and transfer during the process of conflict resolution [Flack and Summers, 1971; Flack, 1972]. This type of research places earlier failures in a different light by suggesting that techniques, as yet undeveloped, can make public participation a more meaningful exercise. For example, an array of professional advocates representing various interested groups might interact, during the planning process, using computer-assisted techniques, Delphi procedures [Dalkey, 1969], operational gaming, and others. Operational gaming, in particular, holds much promise not only for educating decision makers but also for communicating with laymen who might become involved. *The River Basin Model* sponsored by EPA [Environmetrics, Inc., 1971] represents the most sophisticated operational game available with specific focus on water-related issues. However, at this time, little feedback is available to judge its performance.

Other responses of interest to broader planning requirements include the simulation of decision processes and the investigation of alternative futures which might flow from various policy decisions. Bulkley and McLaughlin [1966] formulate a political simulation model which attempts to portray the alignment of various interest groups

relative to proposed water projects. Even though this model is a static or snapshot approach, much useful information can be provided relative to the interactions between technical planning and the existing social decision structure. More recent efforts in this area use principles of Industrial Dynamics [Forrester, 1961] to simulate the process of decision making as it evolves over time [Males *et al.*, 1970; Gates *et al.*, 1970; Males and Gates, 1971]. This specific work focuses on a regional pollution control commission in California and attempts to evaluate the implications of alternative decision making arrangements.

Dynamic models are also useful in revealing alternative future outcomes that might flow from various policy decisions. Such an approach is employed in the well publicised *Limits to Growth* [Meadows *et al.*, 1972] which characterizes future world conditions of population, pollution, etc., as a function of various resource management policies. Also, for the California situation, Males and Gates were able to demonstrate a variety of future pollution patterns resulting from different levels of influence exerted by polluters. They were further able to show that levels of pollution were very sensitive to the emphasis that control authorities placed on "assimilative capacity" as a parameter in regulatory efforts. Kane *et al.* [1972, 1973] employ a similar technique to investigate the alternative future conditions which might flow from various Canadian policies covering sales of water to the United States. At this stage, these investigators emphasize, not an accuracy of prediction, but the capability to integrate and educate teams of investigators including decision makers, laymen, and technical experts.

The Chapter in Perspective

This chapter emphasizes the disparity that exists between current planning requirements and contemporary planning capabilities. It is presumed that both recent examples of planning failure and current efforts to improve planning represent a response to the existence of this disparity. Furthermore, since this gap developed rapidly in our society, which usually changes slowly, it is suggested that powerful forces (that cannot be ignored) must be active. These phenomena along with the presumed importance of the external context relative to planning activities, lead to a brief exploration of external conditions and then to the presentation of certain general requirements that future planning approaches must satisfy:

- (1) Interactions have become the nemesis of water managers; everything seems to affect everything else. Future efforts must pay explicit attention to these "systems" effects;
- (2) Planning efforts must respond to the existence of the larger social decision system. One characteristic in particular, improved access to the decision process, suggests that involved groups must be considered explicitly;
- (3) Goals and objectives can no longer be viewed as given. The naive, ingenuous view of goals, which characterize traditional approaches, must be replaced by the understanding that goals and objectives *evolve* during the process of planning and decision making; and
- (4) Values and value dynamics represent *the* critical ingredient in planning and decision making. In fact the *first-order* consideration in water management can be described as the "resolution of diverse value systems."

Water resource practitioners have only recently responded seriously to these broader planning requirements. These few responses, however, outline the direction to be expected from research into planning and decision making. It will no longer be acceptable to retreat

from these requirements even though our tools for handling them must presently be considered inadequate. Instead, our efforts should focus on the problem of redefining management techniques until they conform more closely to requirements in the external planning environment.

The chapters to follow attempt to move forward, on a broad front, in the effort to address these requirements. Instead of focusing on a specific subproblem, the study is designed to provide an overall foundation for organizing efforts in specific areas. Instead of developing new and original theories, the primary intent is to synthesize into a cohesive package fragmented water management capabilities using where necessary essential concepts from other fields of study. Instead of viewing the general problem from within, an attempt is made to step back and assume a fresh perspective. An example can be used to illustrate this point. The most recent effort to review water resource planning was submitted to the National Water Commission by the Consulting Panel on Water Resource Planning [1972]. According to their report, "the members' *individual experiences* [emphasis added] in planning and administration suggest some [planning] alternatives that appeared worthy of test" [p. 48]. This is not intended to discredit the many years of experience represented by the panel, however, with this initial perspective innovative or imaginative recommendations could not have easily emerged. Their specific proposals in general represent patchwork on existing organizations and procedures, not a systematic attempt to develop more fundamental planning methods.

Little attempt has been made to bring water planning in line with the more current planning theories. Few efforts even suggest that

water management can be cast within general concepts of social action. Although theories of planning and social action themselves seem to be in an evolutionary stage, the effort now to adjust water management concepts to conform to these concepts will permit more meaningful and unified future developments. This reflects the premise that theory represents the only reasoned guide to action; without a minimum of organizing concepts future efforts will teter on the brink of arbitrariness. Only a sound conceptual foundation will allow technology to be placed in its proper perspective and will encourage its proper blending with nontechnical elements.

Many of the specific proposals of this study can be judged only through the test of time. However, certain desirable consequences will emerge from the effort itself. First, the final proposal of a particular planning and decision framework begins to expose critical issues that tend to remain dormant under more traditional circumstances. This framework requires an examination of many difficult questions as a part of its operation and further provides a mechanism for organizing discussion and examination. Thus, the proposal does not allow important factors to be hidden from view. The second spinoff from this study, hopefully an influential one, is that it represents a type of professional soul searching which has not been prominent in the development of water management procedures. Thus, it challenges water managers to look beyond their own history and expertise even if only to counter proposals in the following chapters. Complacency in the face of our changing societal context can be no virtue.

CHAPTER II

SOME ORGANIZING CONCEPTS

One can cite many examples of policies of government in which the failure to recognize that what was involved was essentially a social system has led if not to disaster at least to gross inefficiency. . . . We have neglected the social systems' aspects of the problem, and treat social systems as if they were physical systems.

--Kenneth Boulding [1967, pp. 884-885]

To What End?

The preceding chapter serves as a prologue for the orderly exploration of planning and decision making problems and the recommendation of procedures to mitigate their effects. Primary emphasis focused on the gap that exists between the *substance* and *processes* of contemporary planning and the larger societal overlayer. This gap was singled out as a major contributor to the existence of the water management syndrome. Also, by implication, it was suggested that high priority should be assigned to the task of reformulating planning behavior until it achieves closer harmony with the *substance* and *processes* of the larger social system.

Before undertaking this assignment, however, there needs to be a more solid justification that closer harmony, indeed, would be desirable in itself and that harmony would moderate the water management

syndrome. Proof of this hypothesis can be expected only after operational experience with it, however, experts in planning theory and practice offer reasonable assurance. John Friedmann [1971, p. 318], in particular, emphasizes the desirability of such harmony by calling for the *linkage of a scientific-technical intelligence to organized societal action*. This implies a more intimate linkage between knowledge and the social overlayer than now exists and thus may be deceptive in its simple wording. Even so, Friedmann's conclusion along with the epigraph by Kenneth Boulding provided a central theme for this research. Sections and chapters to follow thus contain organizing concepts intended to enhance the establishment of a *positive bond* between technical capabilities in water management and the larger social overlayer. (Here, the use of "concepts" follows that of Coser [1956, p. 7] who reasons, "Before the 'facts' can speak, they have to be arranged through some conceptual scheme"; here concepts may be thought of neither as true nor false, but as clear or unclear, useful or useless, and so on.)

A Systems Perspective

Although a rigorous "systems" language was not employed consistently throughout this study, the entire problem was viewed from a systems perspective. This represents a definite philosophical viewpoint which has been outlined in Churchman's [1968] *The Systems Approach* and Laszlo's [1972] *The Systems View of the World*.

In very general terms, a system can be defined as a set of interrelated units engaged in some type of action. Hence, a system has certain boundaries that distinguish it from the environment of the set

of units. Furthermore, the system engages in certain interactions with its environment and tends to maintain itself through some kind of equilibrating process. The system also has an internal structure which enables it to meet stresses and to perform certain required tasks.

Using this basic definition of a system, it has been presumed, without proof, that elements and activities in society, including water management, can be usefully viewed as a system and that they behave as systems. The implications of this basic presumption are not entirely clear; however, it is clear that emphasis will change depending on one's initial perspective. For example, a systems view gives weight both to macro and micro phenomena and, in particular, subunit relationships in terms of their effect on the functioning of the whole system. Furthermore, interactions and processes become increasingly visible compared to descriptions of the substance and content of various subunits.

McLoughlin and Webster [1970] provide a useful review of efforts to develop a cohesive General Systems Theory along with a summary of applications of the systems perspective to various fields of study. Much of this earlier systems work is typified by von Bertalanffy [1968] and others [Miller, 1971, 1972; Boulding, 1956, 1968] who emphasize the parallels that exist among all levels of systems from single organisms to total societies. Other investigators have attempted to define these systems parallels specifically in social and political contexts [Buckley, 1967; Deutsch, 1966; Easton, 1965, 1971; Mitchell, 1967; Parsons, 1966; Young, 1968]. The point to be emphasized here is the emergence of a common mode of analysis which transcends the classical disciplines.

For example, through his far-reaching book, *Environment, Power, and Society*, Odum [1971] demonstrates that concepts from General Systems Theory can be applied to complex ecological systems including man-nature-society. Thus, it appears reasonable to proceed here along a systems pathway with the expectation that this perspective will improve, in the future, as a common mode for analysis. As an aside, however, if we include the findings of Fox [1970] and Park and Monks [1972], who describe an inability of our legal and administrative organizations to accept systems solutions (defined somewhat differently), then our optimism must become more guarded.

The Social System

This section contains minimal concepts from other fields of study which begin to form a link between societal action and water management and which begin to elaborate on key "behavioral" components. These basic social system formulations rely heavily on *The Active Society* by Amitai Etzioni [1968] and the voluminous works of Talcott Parsons interpreted by Mitchell [1967] in *Sociological Analysis and Politics*. The expanded image of man draws heavily on Leo Spier's [1971] *A Suggested Behavioral Approach to Cost-Benefit Analysis*, and *Empirical Political Theory & The Image of Man* by Fred Dallmayr [1970].

Most attempts to formulate a general theory of social action begin with a condition of social entropy in which societal units (individuals, roles, collectivities) are arranged in completely random fashion. Economists, when studying problems of public choice, sometimes build social systems in a Robinson Crusoe fashion beginning with a

single person then adding others one by one. However, the former approach seems more convenient here. Thus, we begin with a condition of complete social disorder and require that any theory explain the existence of order and structure which we know exist. In this sense, social *structure* can be defined as sets of interrelated roles, collectivities, norms, and values which guide and permit certain courses of action [Mitchell, 1967]. *Roles* can be thought of as expected patterns of behavior associated with given social positions [Sarbin, 1968; Turner, 1968]; a *collectivity* can be defined as a macroscopic unit with a capacity to act by drawing on common interests and shared values among its members [Etzioni, 1968]; *values* are conceptions of desirable states of affairs that are used as criteria for choice or as justification for behavior [Williams, 1967, 1968; Rescher, 1969b]; and, where values are situation-free, *norms* represent situation-bound specifications of behavior.

Although these elements can be used at any time to characterize structure, to this point in the analysis there exists no need for structure. This need arises once we discover or assign behavioral characteristics to each individual. Here, it will be assumed only that *man has the capacity to act purposively, to exhibit goal-seeking behavior as a means of satisfying his needs.* (More specific assumptions or restrictions will be added as needed.) For the initial case of total social entropy in which no social structure exists, an introduction of this general pursuit of self-interests leads logically to an intensification of inter-individual conflicts described as the Hobbesian state of nature or the war of all against all [Parsons, 1968]. Thus, we arrive at a

condition, based only on the original assumptions, which by logic leads naturally to all-out conflict, i.e., the Hobbesian question. This condition, we know, does *not* exist. According to Coleman [1964a, p. 168], "Whenever one actor's actions have consequences for another, the bases for a social system arise." Hence, under everyday circumstances, it becomes necessary to identify structure and the sources of social cohesion. Furthermore, these structural phenomena contain certain implications for planning and decision making which should become more apparent in sections to follow.

Mechanisms of Social Cohesion (Integration)

To recap, according to Parsons, simply because men differ in their values, norms, beliefs and actions, man cannot avoid but must confront the task of integration at the social systems level. Here, *cohesive mechanisms* will refer to those characteristics of social structure which explain the maintenance of the system as stable, distinct, and cohesive under a range of boundary conditions [Dallmayr, 1960]. Mayer [1972] has described the types of planning problems to which each model or mechanism might apply.

Shared norms and values. Much emphasis, particularly by Parsons, has been placed on the existence of common held values as an integrative mechanism. According to this theoretical position, to insure stability in a social unit each participant must be motivated to conform to expected behavior patterns. Moreover, each person undergoes an intensive indoctrination into the social fabric by which he becomes acquainted with role characteristics and acquires certain values. Thus, cohesion

results since behavior under various circumstances conforms to a consistent, expected, set of internalized roles and values. Certain planning phenomena illustrate the effects of this mechanism. For instance, the manner in which we address antisocial behavior reveals our subconscious emphasis, in planning, on shared values. Instead of exchanging certain desirable items with criminals to encourage appropriate behavior, the penal system attempts to "rehabilitate" inmates, thereby reintroducing common values. In the water planning area, the emergence of clientele groups with values similar to those of construction-oriented agencies encouraged water projects, designed on the basis of shared values, which now are viewed with skepticism.

Exchange. This mechanism, which dominates economic theory, focuses on the individual and his rational pursuit of self interests. From this position, order is established because participants realize the personal advantage to be gained through mutual exchange. That is, competitive interaction and exchange lead to larger gains, more happiness, and subsequently social integration. Voluntary actions are motivated, not by compliant role-playing or shared norms, but by the returns that one expects from others. Homans [1958, 1961], Blau [1964a], and others [Coleman, 1964a; Meeker, 1971] have cast general social action and cohesion in terms of exchange. Political economists, in particular, Downs [1957] in his *Economic Theory of Democracy* and Buchanan and Tullock [1962] in *The Calculus of Consent*, have also attempted to formulate theories of political action in terms of exchange. With respect to planning, the consequences of exchange behavior can reveal themselves in frustrating ways. Plans are ostensibly drawn up on the basis of

collective shared goals, "the public interest," or a single objective or objective function. However, plans find their way to implementation through bargaining, exchange, and mutual accommodation. Thus, "the exchange model suggests that in the absence of shared goals and values plans should be more in the nature of negotiated commitments to act on the part of relevant parties" [Mayer, 1972, p. 134]. The process of standard setting in water quality management certainly conforms to this pattern [Holden, 1966].

Conflict. Proponents of the previous sources of cohesion and integration consider conflict to be abnormal, disruptive, and dysfunctional. However, there are those who consider conflict to be a vital integrative mechanism [Coser, 1956; Deutsch, 1971]. Conflict exists whenever incompatible activities occur in the sense that one action makes another action less likely or less effective. Deutsch, for example, points out that conflict is an energizing activity which stimulates interest and serves as a medium for airing problems; conflict also serves as a mechanism for continually adjusting the balance-of-power and establishing new equilibria; a flexible society benefits from conflict as the agent for modifying or revitalizing norms; external conflict enhances internal cohesion and thus establishes firm boundaries and incorporates structure into society. These represent just a few of the positive benefits which conflict can provide and at the same time begin to reshape our perspective of conflict in water planning. It could be that, instead of avoiding conflict, our management procedures might be designed to capitalize on its positive aspects. (An extensive literature has developed around various components of conflict, even a

Journal of Conflict Resolution.) For example, from a descriptive position investigators have extensively studied conflict and bargaining in behavioral and social psychological experiments. Political scientists have generated a wealth of studies focusing on the power structures and interactions in community decision making. On the other hand, assuming a normative perspective economic theory, game theory, and others have been applied widely to suggest how bargaining and coalition behavior *should* proceed under conflict situations.

Authoritarian rule. To answer the "Hobbesian question," Hobbes himself proposed authoritarian rule as the logical integrating mechanism. Less needs to be said about this device except for its implications for water management. For instance, compulsory hookups to water and sewerage systems and the enforcement of prespecified water quality standards can be viewed as manifestations of totalitarian perspectives. It is not inconceivable, and often it is considered imperative, that totalitarian perspectives be allowed to dominate our efforts to solve environmental problems, especially for our incremental, slowly moving society.

Since each mechanism has its own consequences for planning and decision making, they occupy a vital position in the set of organizing concepts in this chapter. Moreover, the explicit identification of these elements as part of the water management context brings forward in a more visible fashion the implications of various planning activities. It might be possible to construct planning systems which specifically encourage various integrative mechanisms to flourish; or at the very least, it will now be more difficult to concentrate on a single

cohesive factor at the expense of submerging others. This short description of integrating factors leads this analysis into an elaboration on an expanded "model of man" who is presumed to occupy the water management system.

An Expanded Model of Man

Except for the model in economics of rational, calculating, maximizing, goal-seeking, exchange-oriented man, it is doubtful that any other perspective of human decision behavior enters planning activities in any substantial way. Planning usually focuses on production and efficiency and views man only as a part of the process, presuming all along that a harmony exists between the goals of production and the goals of man [Fromm, 1972]. This limited focus has, in its own way, contributed to the disparity identified in the preceding chapter between planning requirements and capabilities. According to Friedmann [1973, p. 7], *"The recovery of the good society requires the recovery of man from utilitarian abstractions to the wholeness of the person and the richness of interpersonal relationships"* [original emphasis].

Thus, an explicitly expanded model of man is required. First, this "behavioral" invasion will emphasize man and that planning is for and because of people. It will automatically expose a broad range of behavioral factors and effects that more restricted models automatically suppress. It will permit the results of less behavioral analyses to be viewed in a more revealing light. Also, it will provide a framework for including, if desired, more than undimensional behavior; for example, exchange behavior alone is unidimensional behavior.

Spier [1971] provides a more appropriate multidimensional paradigm for human behavior, one based on the interaction between man's needs and the resources available to satisfy these needs. His purpose was to bring our perspectives (as planners) of man into closer conformity with contemporary models of human personality and behavior. Among other factors, this expanded model includes the man-environment interaction, broader motivations for behavior, internal and external perceptions, and, in general, a more realistic psychological and "behavioral" perspective. An abstraction of his premises appears below:

- (1) The central objective for man is satisfaction of needs underlying self-maintenance;
- (2) As a psychological consequence, man has the capacity for positive-negative evaluation of this objective;
- (3) Man must rely on environmental resources, whose qualities generate specific patterns of action;
- (4) Based on his perceptions, man formulates specific norms and values for appropriate courses of action;
- (5) The perceived nature of need (internal factor) determines the type of behavioral response; and
- (6) The perceived resource qualities (external factor) determine spatial and temporal variations in behavioral response.

These basic determinants can be expanded into a multidimensional representation of behavior by drawing upon concepts from other disciplines, like psychology. It will come as little surprise that this more complete portrayal of human behavior also follows closely the diverse mechanisms for social integration. In fact, each specific cohesive mechanism represents, loosely, one component of behavior to be

expected in a more complete composite behavioral model. The parallels in Table 2.1 emphasize the nature of these dimensions.

Economic man. This actor can be described as a goal-oriented self-directed, calculating, maximizer. No doubt, in the business world and other circumstances this component of human behavior often dominates. It certainly represents the predominant model in planning behavior.

Social man. However, men often are motivated by factors beyond those of pure self-interest. This may in part be a result of the internalization of certain norms and values usually directed towards a contributing harmony with others, family, and society. In fact, "the maximization of approval . . . could be viewed as the counterpart in sociological theory to the maximization of profit in economic theory" [Dallmayr, 1970, p. 455].

Political man. In contrast with previous components in which power is balanced (economic) or absent (social), man continually engages in various levels of conflict in which power becomes an actualizing factor. In this case man becomes a power seeker and maximizer of self-determination. Through this component man can realize his willingness-to-pay (economic) and willingness-to-contribute (social) by supplying power and a willingness-to-act. Hence, without explicitly introducing political man, we lock out the very component which makes willingness-to-pay a viable tool in certain water resources analyses.

Spier [1971] should be consulted for a more complete description of human behavior in terms of need-resource pairs, corresponding to each behavioral dimension. In reality, each actor combines all three

TABLE 2.1. PARALLELS FOR MULTIDIMENSIONAL MAN
(Adapted from Spier, 1971)

NAME	FOCUS OF BEHAVIOR	PSYCHOLOGICAL PARALLELS	SECTOR PARALLELS	CORRESPONDING RESOURCES
<i>economic man</i>	<i>self directed</i>	<i>id</i> (<i>internal world</i>)	<i>business</i>	<i>material</i>
<i>social man</i>	<i>other directed</i>	<i>ego</i> (<i>external world</i>)	<i>family</i>	<i>subjectively perceived</i>
<i>political man</i>	<i>symbol directed</i>	<i>super ego</i> (<i>moral world</i>)	<i>government</i>	<i>non-material</i>

dimensions in various proportions. For example, an industrial manager may well be president of the local Sierra Club and member of a Board of Commissioners. His overall behavior would reflect the nature of his personality components, his position in the social structure, and many other factors. "Because he is continually suspended among three dimensions, he inevitably interchanges the governing values and . . . develops a composite personality . . ." [Spier, 1971, p. B-682]. Thus, the implications for planning and decision making become clearer. If plans are formulated presuming unidimensional man or, as is often the case, no conscious model of man at all, should we as planners be surprised when our plans fall on disbelieving ears? It seems that if planning procedures account for the existence of multiple components, or at least do not unreasonably suppress a particular dimension, then our methodologies can be considered more representative and more clearly linked with "behavior" in the social system.

A diagram of these factors appears in Figure 2.1, which attempts to describe this variable behavior important to water management situations. For example, any particular water program can be characterized in terms of its three resource dimensions: material resources, subjectively perceived resources, and nonmaterial resources. Each of these resource dimensions relates itself to a particular component of behavior respectively, economic man (em), social man (sm), political man (pm). Spier feels that needs and resources, as initiating forces of behavior patterns must now be treated as mutually interdependent variables because needs are defined by resources and resources determined by needs. Thus, resources must be disaggregated from their natural state

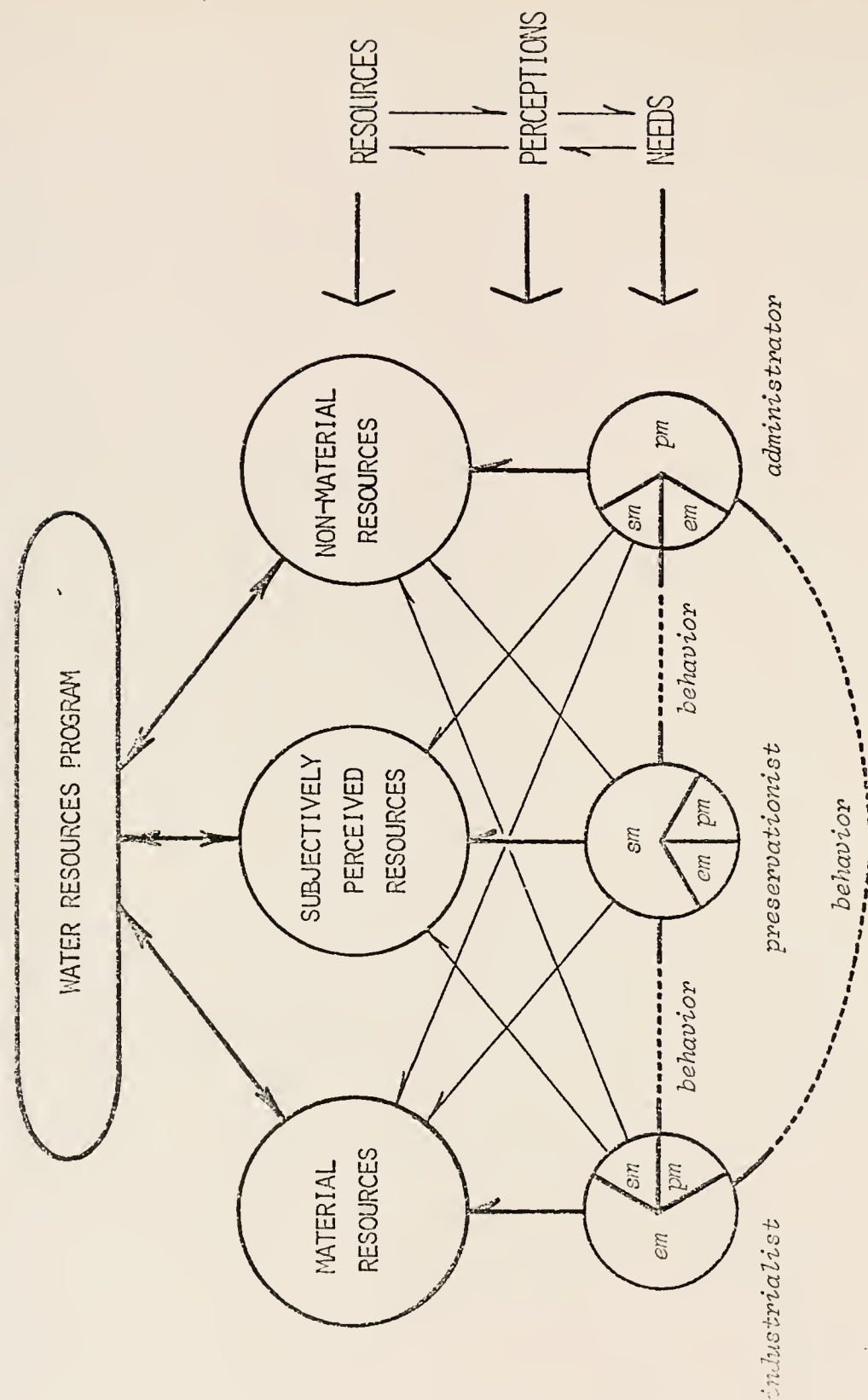


Figure 2.1. Multidimensional Human Behavior as a Function of "Need-Resource" Pairs

according to those qualities that relate to each possible component of action. The preceding triadic classification of man corresponds to Spier's categories: *material resources* for physical needs, *emphatic resources* for emotional needs, and *incorporeal resources* for intellectual needs.

In Figure 2.1, the planning and decision climate is shown to be defined by interactions among three functional interest groups represented by an industrialist, a preservationist, and an administrator. Though each representative has a composite personality, each tends to place different emphasis on a dominant behavioral component. Furthermore, each personality component relates to its corresponding resource group through a set of perceptions and interpretations which "give life" to each need-resource pair. Behavior then occurs as a response to these conditions guided by value systems associated with each person (interest group).

Spier [1971] provides a more elaborate account of this behavioral model which has numerous implications for the water management process. The first flows from the fact that traditionally water projects have been characterized primarily in terms of their *material resource* component. This provides easy access for the economic man dimension of each decision maker since this need-resource pair is complemented. Other behavioral dimensions cannot establish the necessary interactive pairing and are thereby reduced in potency and visibility. If planning proceeds according to this restrictive model of behavior, then it might be no surprise when demands for more responsiveness to other dimensions appear.

This model also suggests the possibility of an analytic formulation of behavior, one that more nearly satisfies what has been learned about actual human behavior. It suggests new data requirements drawing heavily on techniques now existing and to be developed in the behavioral sciences. In addition to describing and simulating behavior more appropriately, the model also reveals the possibility of moving to new levels of normative decision models.

However, for the present time Spier's model has a slightly different meaning. It reveals the importance of multidimensional behavior and places in critical perspective earlier planning efforts. It may not be possible now to develop full-blown expanded decision models. It may be difficult now to introduce behavioral data into the decision process in a decisive way. But, it does seem possible to permit a freer interplay of all dimensions during the planning process to eliminate any unwanted systematic bias. This places a responsibility on those who recommend planning procedures for future application.

The General Theory of Action

This chapter opened with the task of establishing a more explicit linkage between scientific intelligence and organized societal action. But, at first glance, societal action seems to be characterized at the very least as complex and unpredictable, not something to which one could effectively extend a linkage. Thus, before this task can be accomplished, it becomes necessary to formulate a model of societal action which imparts some order and consistency to the apparent disorder. A set of organizing principles for the social overlayer

would establish a basis for the orientation of water management in much the same way that a single jigsaw piece fits into a larger, interlocking puzzle. Moreover, the lack of such a cogent frame according to Ozbekhan [1968b, p. 49], "forces increasing numbers of people to try to invent, ad hoc, an orderly view . . . by the almost frenetic exercise of disconnected kinds of planning. . . ."

For this reason, the preceding paragraphs outlined very briefly the condition of social entropy, the mechanisms for social integration, and an expanded model of man. With these concepts as building blocks, it now becomes possible to establish a conceptual order in societal action which can serve as a working base for further analysis of water management. Several schemes could be used for this purpose, however, because of its systems orientation, the *General Theory of Action* formulated by Talcott Parsons serves this purpose best. Etzioni's *The Active Society* will be used as the source of more detailed interpretations of the general framework since it focuses on the level of social development called "active," corresponding to the general direction of contemporary American Society.

The *General Theory of Action* represents a structural-functional approach [Flanigan and Fogelman, 1967; Holt, 1967; Mitchell, 1967] which tries to explain the operation of a system in terms of the basic *functions* which characterize the system's operation. Here, function can be defined as any consequence of a pattern of action required for the continued existence of the system [Dallmayr, 1970]. Thus, structural-functional analysis includes:

- (1) Determination of the unit of analysis;
- (2) Identification of the conditions necessary for the unit's persistence; and
- (3) Identification of the structural arrangements through which functions are performed.

Earlier paragraphs specify the social system as the basic unit of analysis. Then, Parsons assumes that the master problem of a social system is self-maintenance. Furthermore, in order to maintain itself, a social system must successfully solve or successfully cope with certain fundamental, universal subproblems. Thus, given a social system requiring order and inhabited by men with certain personalities, several logical inferences can be drawn concerning the requirements for system maintenance. According to Parsons [Mitchell, 1967], every social system is confronted with (1) adapting to an environment, (2) achieving collective goals, (3) controlling tension within the system, and (4) integrating the actions of its members. There is no priority in importance, and solving one problem will not completely solve another.

The first problem, *adaptation*, refers to the problem of providing facilities for use by the system. This function is required because goals cannot be satisfied without resources, but resources are not useful until they have been converted by facilities into useful forms.

The second problem, *goal attainment*, is very closely related to the first since it includes both goal selection and the mobilization of necessary resources. Man has the capacity for goal oriented behavior and encounters goal conflicts which must be resolved through some form of collective action.

Internal problems arise because the system must maintain its major values or decision criteria in order to survive. The problem is one of indoctrinating members with appropriate values and motivations to maintain support and to guide their actions. Thus, the next requirement for *pattern-maintenance* or tension management involves upholding the basic ordering principles of the system.

As the system becomes more complex the problem arises over handling interpersonal difficulties and coordinating actions. *Integration* refers to the control of behavior by the application of external positive and negative sanctions. Integration concerns the adjustment of relations among units of a system, particularly with regard to the allocation of advantages and disadvantages, to insure that the units will contribute to an order desirable for the system [Parsons, 1966]. Getting people to work together who have just competed over scarce resources, especially when the game assumes a zero-sum quality, poses the integrative problem. Even in the absence of scarcity, integration remains a problem because of the need to coordinate men with various values, beliefs, norms and interests.

Now, given a condition of social entropy along with these functional requirements, how does structure enter the system? Parsons contends that society becomes structured or differentiated around these four universal problems. Various subsystems emerge to solve each basic functional problem, and as societies become more advanced, one would find increasing degrees of specialization along functional lines. That is, social systems develop specialized means for performing each function using as shown in Figure 2.2, a *goal-attainment* subsystem,

FOUR FUNCTIONAL SUBSYSTEMS PARSON'S GENERAL THEORY OF ACTION

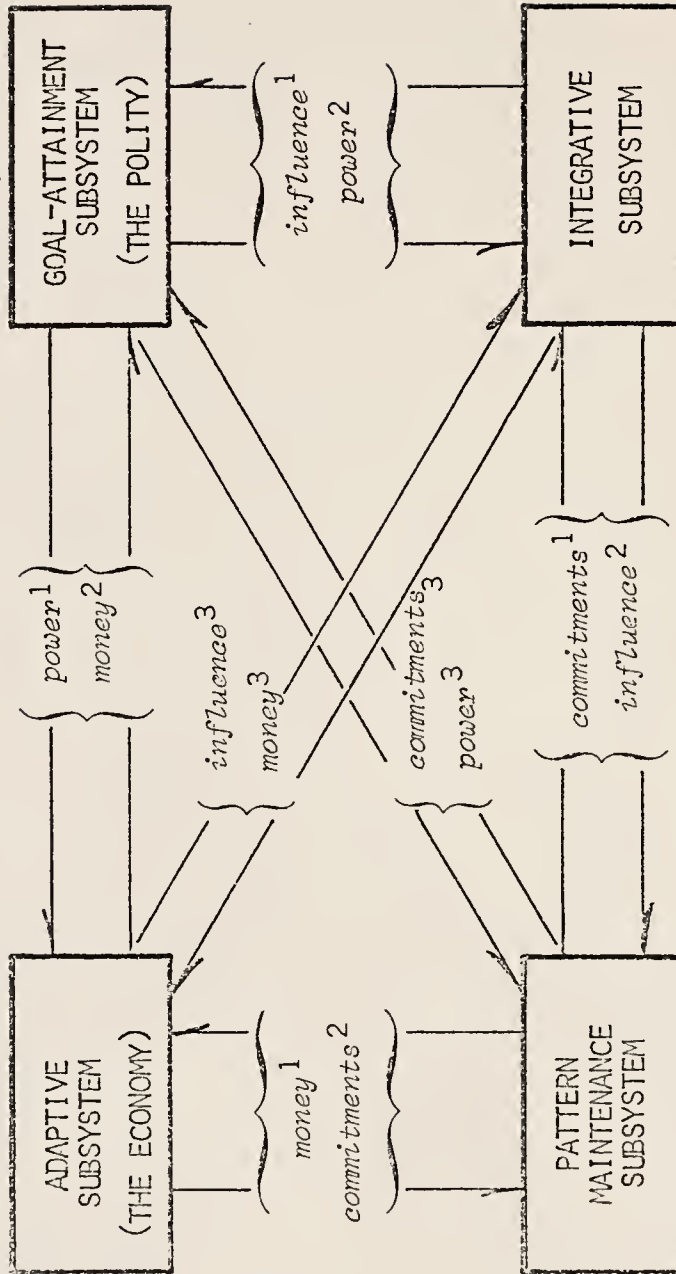


Figure 2.2. A General Theory of Action

adaptive subsystem, *pattern-maintenance* subsystem, and *integrative* subsystem. For large social systems these subsystems become differentiated and distinct. In smaller systems where face-to-face relationships predominate, the subsystems become more diffuse, but the functional problems must be met nevertheless.

Next, in order to have a complete model of social action, at this level of generality, it becomes necessary to specify the interdependencies among the four subsystems in Figure 2.2. Parsons' general solution was to show that these functional relationships take place through a set of boundary exchanges, or inputs and outputs, among the various subsystems [Mitchell, 1967]. Every unit must engage in plural interchange relations with other units in order to acquire certain essentials of functioning (factor inputs), and dispose of its contributions to other units in this division of labor (product outputs). This requires double interchanges between the subunits (Figure 2.2), and it necessitates the development of generalized symbolic exchange media--money, power, influence, and commitments [Parsons, 1966]. Referring to Figure 2.2, there are six distinct double interchanges required for the complete integration of the four functional subsystems. Each of these interchanges are in turn coordinated by other subsystems which are identified in Figure 2.3. This second diagram, at this point, serves only to establish the first-order linkages between the primary functional subsystems.

The components outlined in Figures 2.2 and 2.3 portray a generalized theory of action for *any* social system. Furthermore, observed differences among social systems in real life result, not because the

general theory of action is inappropriate, but instead because various societies approach the operation of subsystems with different emphasis. However, the same four functional subproblems must be solved in each case, and Parsons attempts mainly to give conceptual order to this. He accomplishes this by relating the *decisions* and *actions* of men engaged in their different *roles* [Mitchell, 1967]. In this way, Figures 2.2 and 2.3 serve primarily as an analytical device since the basic unit of analysis in this social system is a *role* not an individual person in the biological sense. Mitchell [1967] further explains that these actions are governed by institutions and take place according to relatively stabilized rules. Hence, one may call these actions "processes" of decision making at both the individual and societal levels. Such actions would include, for instance, a market, an election, a bureaucracy, and so forth. These actions, of men engaged in roles, then generate the double boundary exchanges which connect the four functional subsystems. Thus, the movement of symbolic media (arrows in Figure 2.2 and 2.3) in society results not from the application of some "hidden hand" but rather from concrete actions of persons acting in roles.

Before turning to the next section, it will be useful to examine one particular double boundary exchange in more detail. In Figure 2.4, the goal-attainment and integrative subsystems are isolated to allow closer examination. Parsons [1966] equates the goal-attainment unit with the more common concept of the polity which includes all action concerned with the function of the collective pursuit of collective goals. Integration refers to the distribution of advantages and

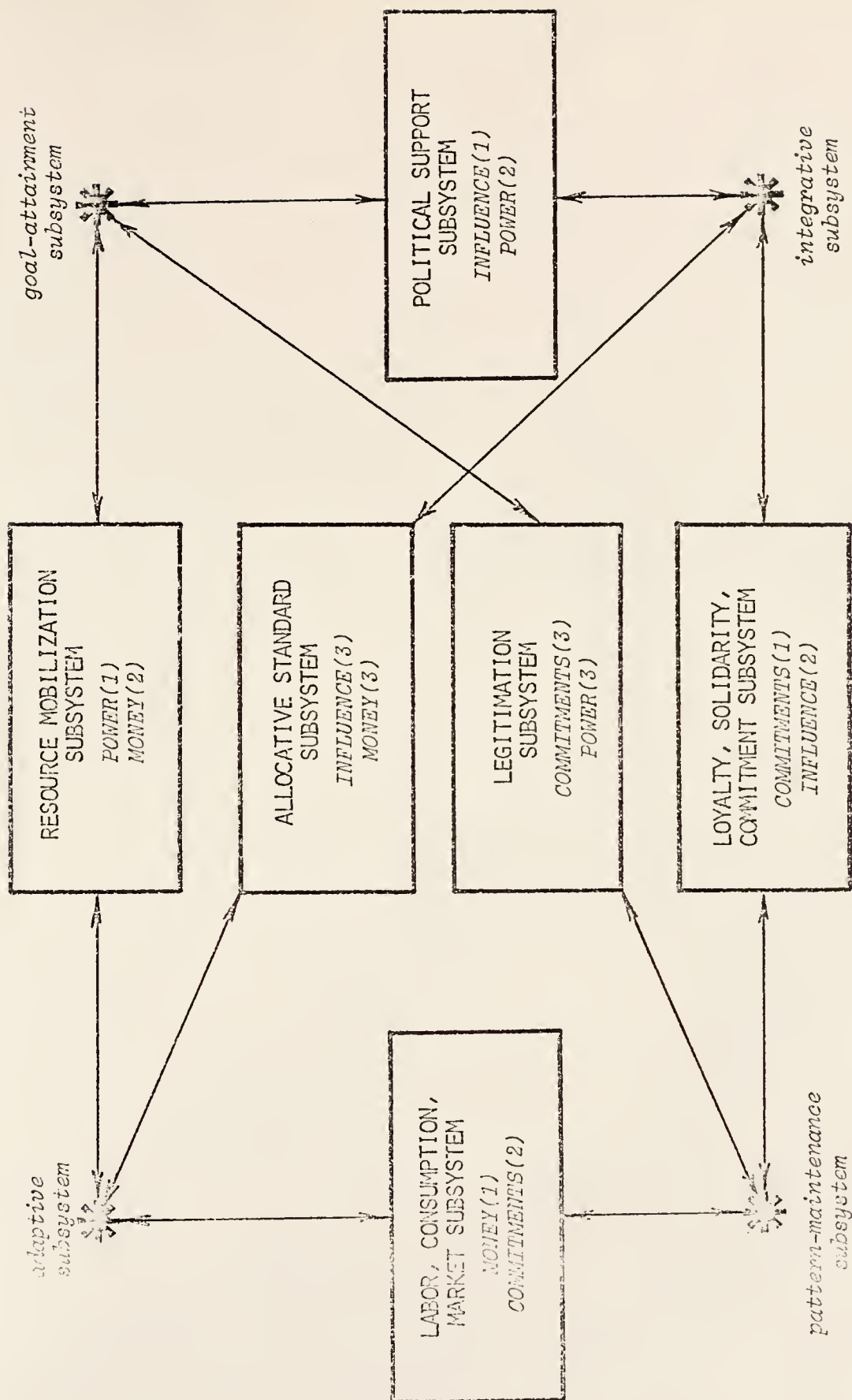


Figure 2.3. Subsystems for Coordinating Double Boundary Exchanges

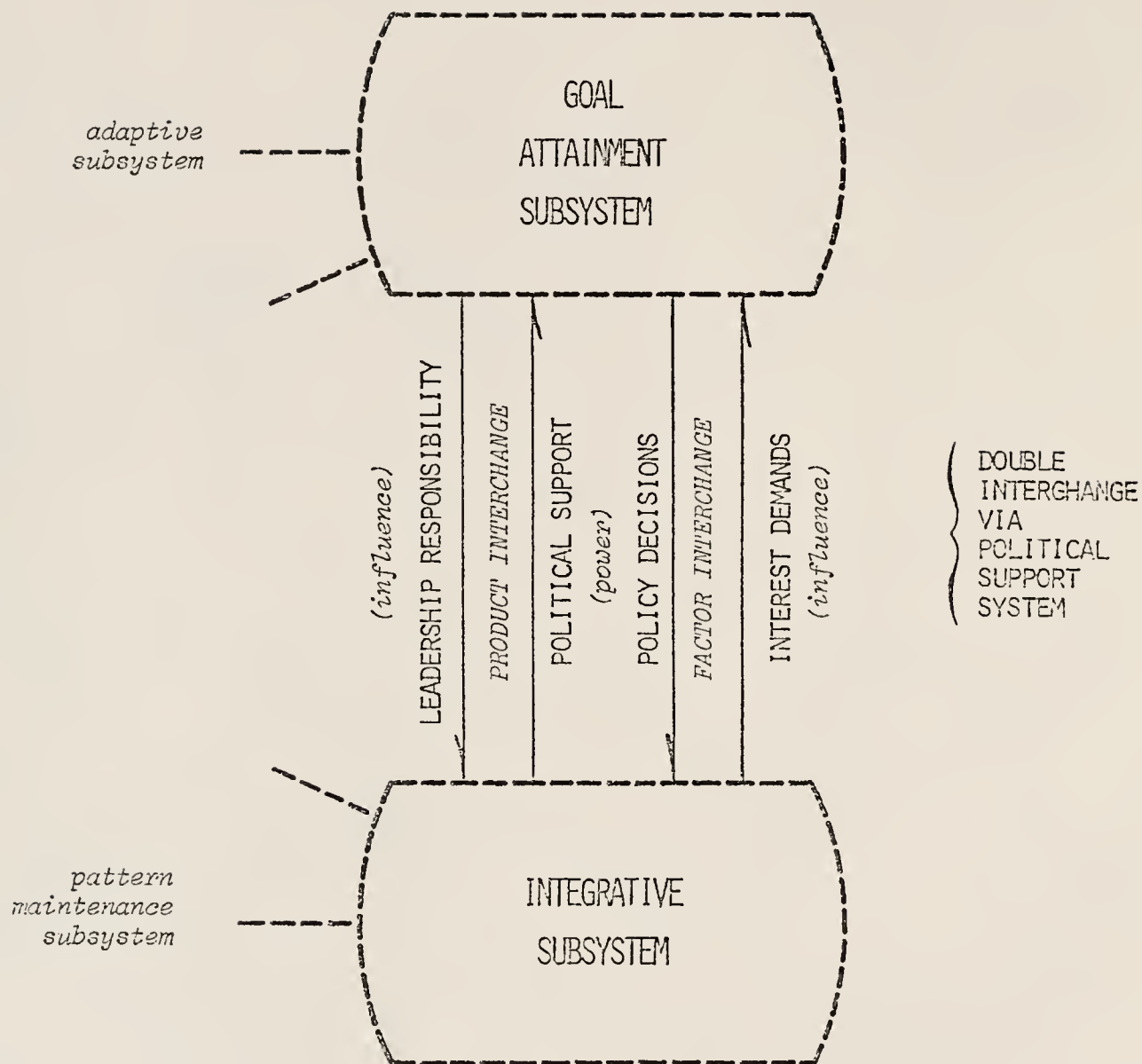


Figure 2.4. Interaction Between Parsons' Polity and Integrative Subsystem

disadvantages to ensure that societal units contribute to the overall order of the system. As with other boundary interchanges, this one includes an exchange of factors essential to the functioning of each unit along with an exchange of products which contribute to other units in the division of labor.

Considering the factor exchange, the polity receives interest demands through the medium of influence (persuasion) which, through its internal processes, are transformed into policy decisions, a form of power. Properly framed, policy decisions obligate members of the collectivity to attain goals represented, in part, by interest demands. On the product side, members of the integrative subsystem provide support (power) in terms of votes, generalized commitments to the established process, etc., in exchange for leadership responsibility (a form of influence). According to Parsons this product can be interpreted as an output of the polity in the form of leaders who take responsibility for the implications of their decision which is in turn exchanged for support.

Looking at these exchanges in another way permits a preliminary "tracking" of media as it circulates in the social system. For example, influence flowing into the polity from the integrative subsystem is partially returned in the form of leadership responsibility. Other exchanges of influence also involve the adaptive and pattern-maintenance subsystems. This, then, provides a rudimentary scheme for following the flows of a single medium and, perhaps, for investigating the total balance of inflows and outflows. The same can be said for power which

originates or is anchored in the polity. Power represents a more specific media than influence (persuasion) in that power can be exchanged for binding obligations. With regard to Figure 2.4, power flowing from the polity in the form of policy decisions is partially balanced by power acquired from the integrative unit as support. As with influence, this begins to provide a more complete representation of the ebb and flow of the various forces at work in the social system.

Earlier paragraphs identified the need for relating planning and decision making activities to organized societal action through some type of linkage or positive bond. To accomplish this, it first became necessary to search for and identify a source of structural integrity for the larger social system which would serve as the anchor for subsystems containing planning. At this level of abstraction, the General Theory of Action now begins to establish order among the complexity and disorder of social affairs. Given a society without structure, inhabited by men engaged in roles with a capacity for goal-seeking behavior, the emergence of social structure was explained as the attempt to solve four functional problems. This conceptual model, therefore, has analytical and intuitive appeal and is independent of specific situations or data requirements. Parsons has as yet not attempted to operationalize his collection of "stocks and flows," and he may even feel that operatinality has a low priority [Mitchell, 1967]. However, the primary contribution of this general theory lies in the overall organization which it provides. Any collection of individuals operating in roles must, in concept, face the four functional problems, and any explanation

of their activities would be incomplete without reference to this underlying structure. It thus becomes more difficult to focus on the economy or the political system as isolated from the rest of society. It becomes more difficult to analyze a particular social demand or issue as a technical subproblem without placing the question in the larger context of social affairs. Furthermore, the General Theory of Action establishes the common ground from which individual water problems can be placed in more meaningful perspective.

The Water Resource Management System

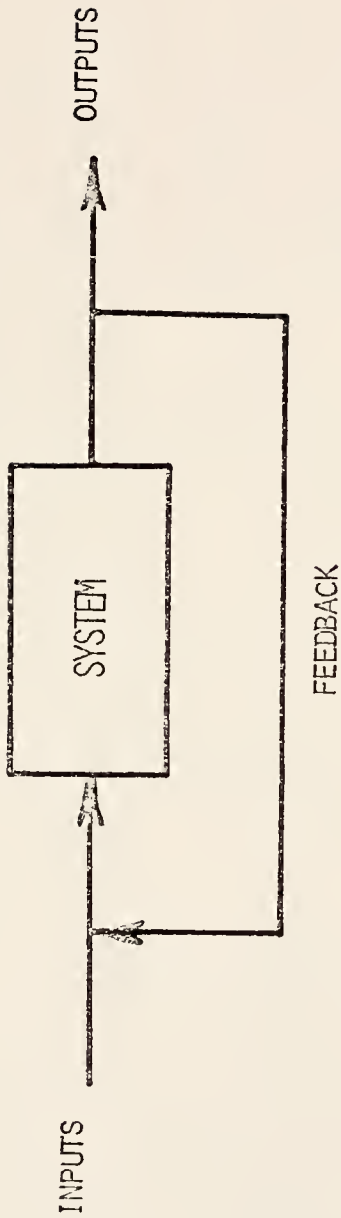
The preceding discussion now provides the opportunity to relate water management activities to the larger social system while maintaining a degree of order. The fact that this exercise is meaningful has been suggested by Vlachos [1971, p. 722], "If . . . most of the problems of natural resources have as their roots considerations of individual, collective, and organizational behavior, as well as concerns of public policy, we need to raise the central questions of how do we approach in a theoretically integrated and methodologically consistent way the social dimensions of natural resources." Hence, this section begins to relate the foregoing general concepts to the specific problem at hand, water resource management, as a means of introducing methodological consistency in the form of, at least, a first approximation.

To accomplish this one must assume that the elements and activities which comprise water management can be perceived as a "system." An earlier section put forth a preliminary definition of a system as a set of interrelated units engaged in some type of action. Other char-

acteristics of a system include boundaries which separate the system from its environment, a tendency toward self-maintenance, along with an internal structure which allows the system to resolve stresses placed on it. Figure 2.5 contains further characteristics which help identify a set of interrelated units as a system. These include the existence of inputs from an external environment which the system can transform into outputs or effects. Also since the system is a self-maintaining, goal-seeking arrangement of elements and activities, some type of feedback is required whenever outputs do not meet established goals. Without detailed elaboration here, it appears reasonable to assume that one may talk in terms of a water resource management system. Interrelated units certainly exist along with boundaries which separate these units from an external environment. Specific inputs can be identified, as well as outputs. Furthermore, the continual effort to improve water management procedures reflects the existence of at least minimal amounts of feedback.

From this assumption, it next becomes necessary to relate the water resource management system to the larger social system described earlier. As a review, a social system may be defined as consisting of two or more persons who are engaged in a relatively persistent, patterned form of interaction [Mitchell, 1962]. This provides a key to the relationship which should exist between society and the WRM (sub) system. But, a difficulty arises over the fact that WRM focuses on a specific issue or problem. Should the water management problem be viewed only as a single functional problem of social action? In this case the WRM subsystem might be viewed as a specialized unit similar in

WHAT IS A SYSTEM?



A REASONABLY WELL-DEFINED ENTITY:

1. ACTED ON BY EXTERNAL FORCES; (*Inputs, Forcing function*)
2. WHICH IT TRANSFORMS; (*System, Transfer function*)
3. INTO SPECIFIC EFFECTS; (*Outputs, Response function*)
4. WITH FEEDBACK;

Figure 2.5. Definition of a "System"

nature to one of the four functional subsystems of Figure 2.2. However, considering the definition of a social system, it appears that water management meets the requirements and may reasonably be viewed as a small social system in itself, not just a specialized functional subunit. As it turns out, this distinction may not be serious, however, for the remaining sections the relationship between Parsons' social system and the WRM subsystem will follow the pattern in Figure 2.6. From this perspective, WRM can be viewed as an overlay or extraction from the larger social system. Implications flow immediately from this interpretation; to name one, the WRM subsystem must solve the four functional subproblems similar to society at large. Furthermore, the WRM subsystem may, depending on its size and complexity, develop specialized subsystems to address the functional problems and to handle the double boundary exchanges of symbolic media. Moreover, we now have an analytical structure through which more detailed investigations and analyses may be performed in a systematic fashion.

Thus, like any social system, the WRM system is structurally composed of units and their relationships. Since the WRM system is also a collectivity, its subunits are always "members" that may be individuals acting in roles or subcollectivities which themselves are ultimately reducible to individual persons in member roles [Parsons, 1966]. For analytical purposes, then, the WRM system in question will be defined as that collection of roles involving coordinated action directed to the attainment of the collective goals in the system. This involves making decisions with regard to the implementation of the collectivity's values in relation to internal and external situations.

FOUR FUNCTIONAL SUBSYSTEMS
PARSON'S GENERAL THEORY OF ACTION

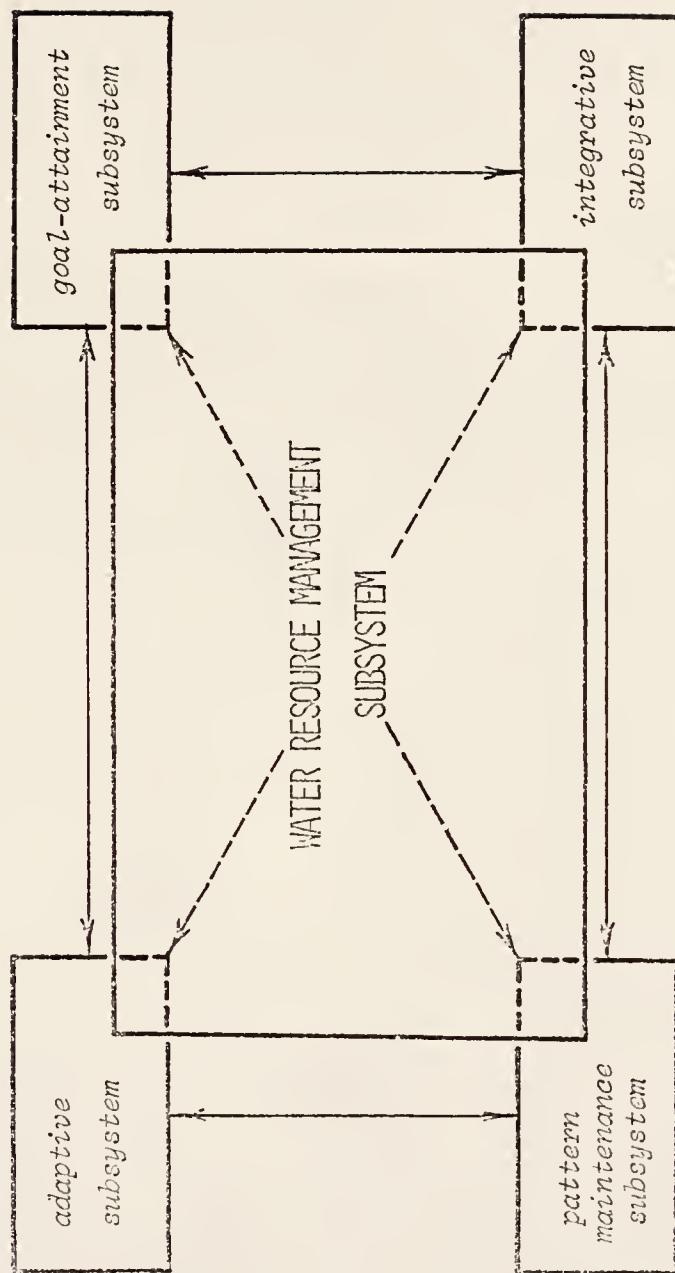


Figure 2.6. Society and the Water Resource Management Subsystem

In this respect, the WRM system also considers relationships with physical facilities, the natural environment, other collectivities, and so forth.

Using this generalized definition, the WRM system can be recast in diagrammatic form similar to Figure 2.5 which will permit more operational analyses through this type of systems-logic. For example, the flow diagram in Figure 2.7 begins with an external environment which establishes the context for expressed *needs* and the *resources* available to satisfy these needs. A statement of needs and resources serves as input to the planning and decision subsystem which transforms these into outputs in the form of specified *water related activities*. These activities, as output, include policies, programs, and facilities, which in turn become inputs to the social and natural subsystems to which they apply. Interactions with natural and social subsystems transform water related activities into a statement of *effects* or *impacts* which measure any *changes* produced by water activities. Then, in terms of system *goals* these effects provide a measure of overall system performance, that is, how effectively (and efficiently) the system mobilized resources to satisfy needs. If performance is judged to be inadequate, a *feedback* (of information, money, power, etc.) occurs to modify components for the purpose of improving performance. If performance is judged to be adequate, feedback occurs to prepare the system to begin again whenever inputs require further processing. The same flow of activities appears in Figure 2.8 which expands planning and decision processes into two phases, *plan formulation* and *program implementation*. By accepting these two diagrams as reasonable representations of the WRM system numerous important observations emerge.

WATER RESOURCES MANAGEMENT SYSTEM

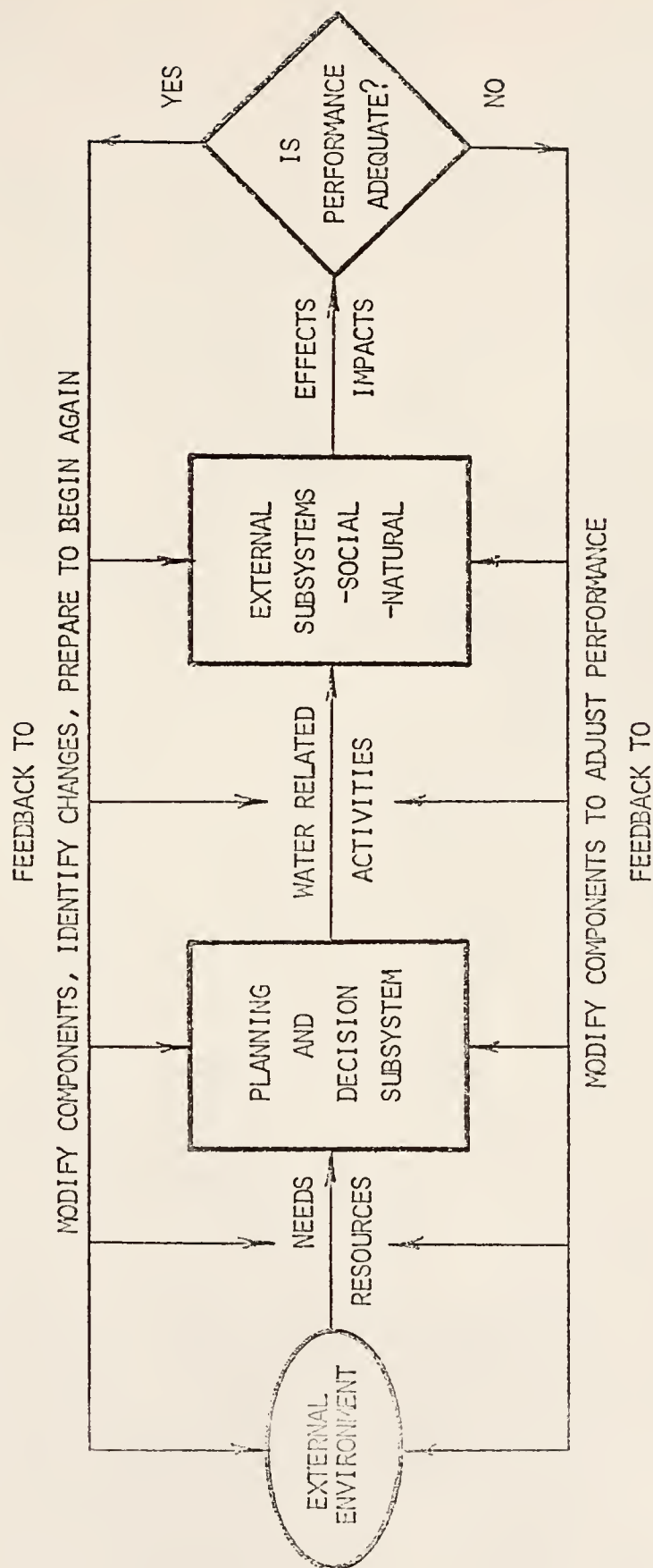


Figure 2.7. The WRM Subsystem in Systems-Logic Form

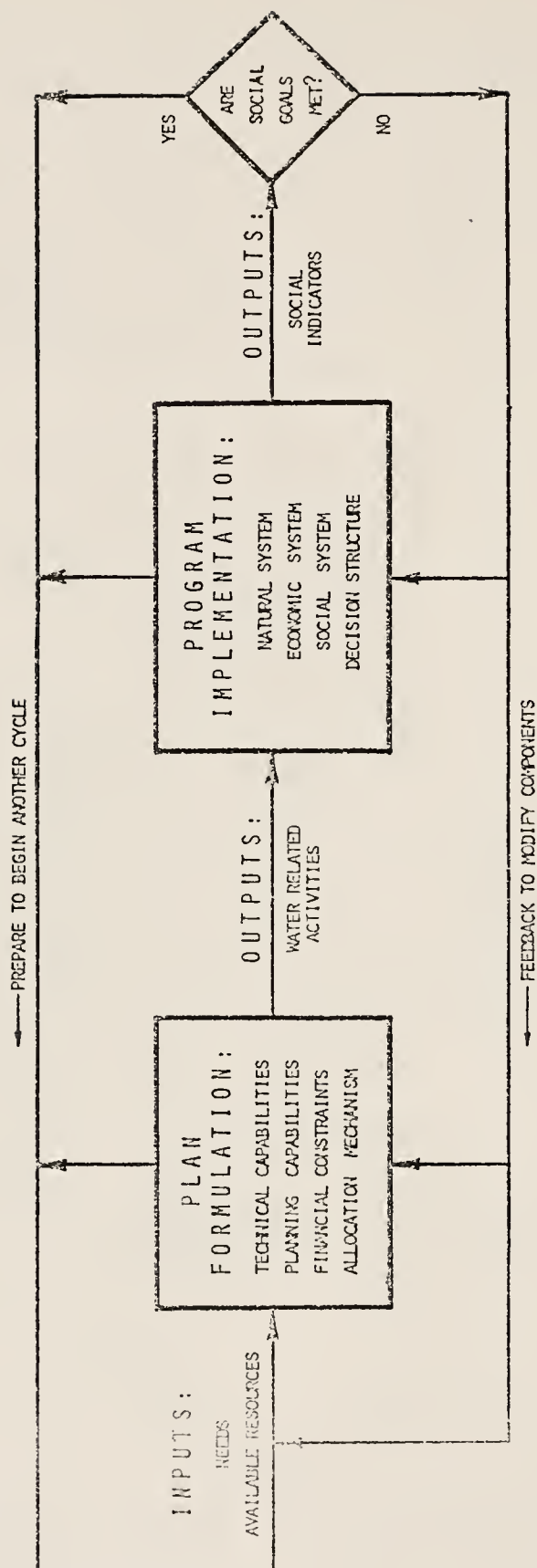


Figure 2.8. The Planning and Decision Subsystem Expanded in Systems-Logic Form

Total system perspective. Water resource management is embedded in a social system which makes it hazardous to consider only a technical-economic slice during the analysis of water problems. In this regard, Hill [1971, p. 171] pointedly remarks, "A primary need is for the decision maker in the technical realm to realize first that social systems exist as do technical and physical systems." This does not mean that water managers must be sociological theorists. Instead, it suggests that planning procedures be adjusted until they "become congruent with the conditions of the social environment" [Friedmann, 1971, p. 320].

Social system dynamics. This observation refers to the analytical tendency, if the larger system is considered at all, to regard the social environment "as rigid constraints rather than integral, highly mutable parts of a unified system, itself regulated by environmental constraints" [Thompson *et al.*, 1972, p. 56]. This tendency began originally as a means for dealing with external complexities and has subsequently evolved to the status of standard procedure. Ciriacy-Wantrup [1971] identifies the pitfalls of this approach and proposes a three-level hierarchy of decision systems to alleviate this difficulty. Although techniques, including his, do not exist to fully resolve this problem, it is necessary to keep the issue alive. Expediency may require that external conditions be viewed as constraints. However, this exercise should be performed with caution and with full knowledge that the opposite is true.

Implementation. Plan formulation and program implementation must be considered together as interactive, integral components of the

larger decision system. Hence, Flack [1971, p. 321] is only partially correct when he states that "implementation of plans must receive as much attention and concern as the design of alternatives." This remark suggests correctly that the total effort will be no stronger than its weakest link but does not stress the existence of important interrelations between the two activities. Formulation and implementation should be viewed as interactive and more nearly equal in status. Both phases should be blended with organized societal action, with little emphasis on a strict sequence of action.

A brief aside will be useful for illustrating these points and will serve as a prologue for concepts and procedures to appear later. Until recently, implementation has been given only lip service usually appearing as a small block at the end of a large flow chart of planning activities. However, this phase of planning is gradually receiving increased attention as a valid activity in its own right. Bunker [1972] has investigated potential implementation strategies and identifies at least three primary requisites:

- (1) Identify the relevant leverage points as individual or collective actors in the situation;
- (2) Specify the specific impact on each actor essential to effective support for action; and
- (3) Design means to achieve movement of at least a minimum coalition of actors to participate in execution.

Borrowing from Gergen [1968], Bunker continues his analysis by using a three-dimensional model for identifying and assessing the relevant leverage points. The diagram in Figure 2.9 portrays each source of power and influence as a composite of three parameters, power

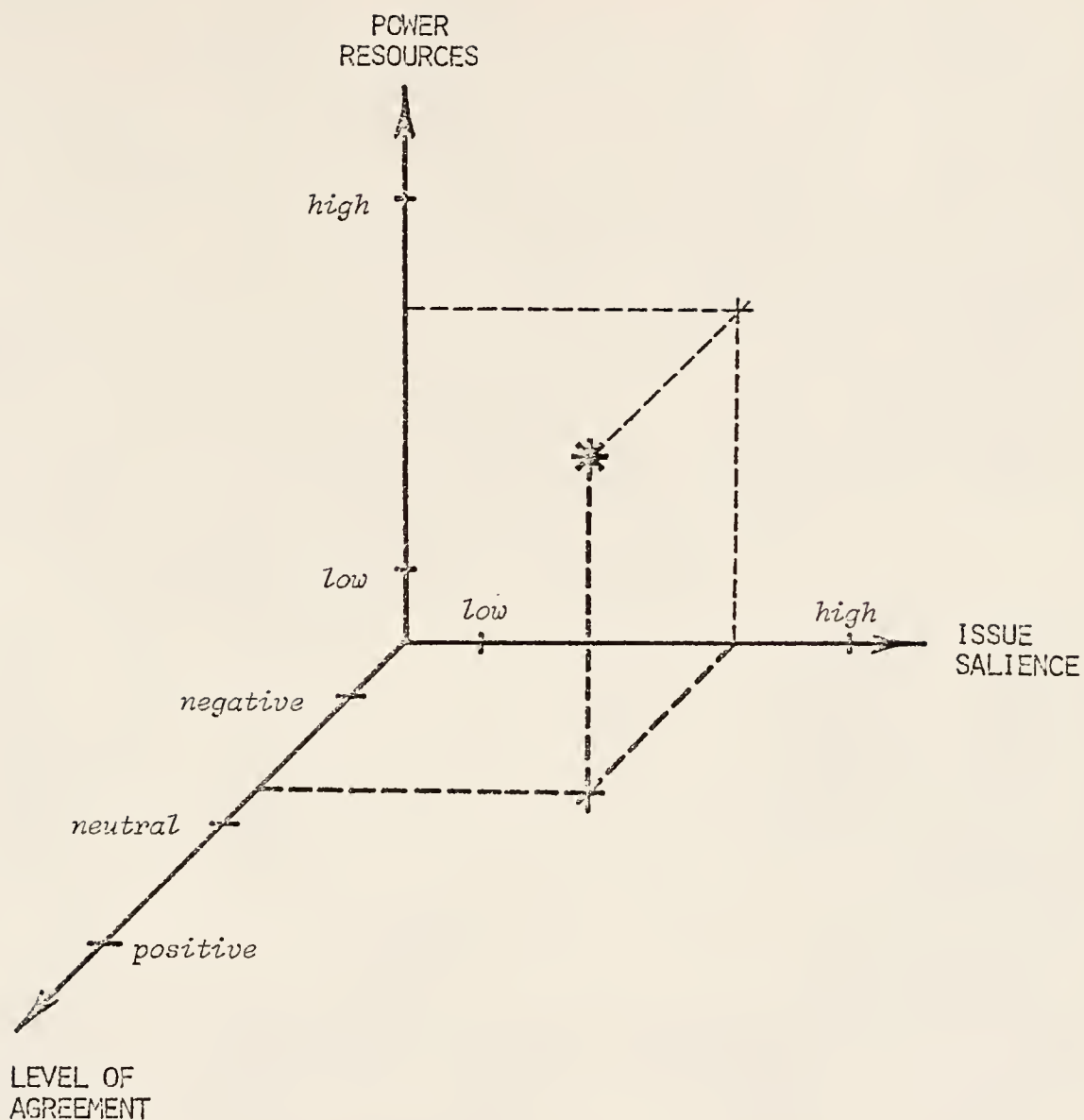


Figure 2.9. A Three-Dimensional Model for Assessing Leverage Points
(Adapted from Gergen, 1968; and Bunker, 1972)

resources, issue salience, and level of agreement. Power resources can be defined by the number and potency of political resources the actor has available. Issue salience refers to the amount of attention which a single issue commands when all issues important to the actor are considered. Level of agreement represents a measure of the position of the actor relative to the specific issue considered. With these three parameters, the logic suggests that all actors potentially involved with implementation may be located somewhere in this 3-space. Carrying this logic a step further, by quantifying the three dimensions and comparing parameter spaces among actors, it might be possible to generate estimates of conditions crucial to implementation [Bunker, 1972].

These observations can be placed in a more meaningful perspective by comparing two different decision models, one technical, the other nontechnical, which impinge on the selection process in water planning. First, consider the technical procedure which may include economic and operations research techniques which maximize some predetermined objective, say, net benefits, within the domain of technical, economic, and legal feasibility. However, the application of a technical decision rule like this, which selects a plan for us, can be deceptive. The larger social decision system transcends this technical block and filters out those plans which do not conform to the nontechnical rules existing at other decision levels. Ingram [1971a, 1972] identifies nontechnical, but dominant, decision rules and has traced their application through the multilevel water resource decision system. (Actually, Ingram's purpose in establishing this model was to illustrate the manner in which these informal rules have changed in light of

current environmental consciousness. For example, it is now more common for one agency to evaluate critically the environmental programs of another thereby complicating the objective, "minimize interference.") Thus, we can recast project formulation as a combination of both types of decision rules which more closely represents the operation of the total decision system:

Technical Rule: Maximize net benefits

Nontechnical Rule:

1. Maximize local support
2. Minimize controversies
3. Maximize mutual accommodation
4. Minimize interferences
5. Maximize fairness

Subject to:

1. Technical, economic, and legal constraints
2. Benefit cost ratio ≥ 1.1
3. Discount rate $\geq$ some minimum value
4. Sum of costs for all projects $\geq$ last year's total
5. "Political Quotient" $\geq$ some minimum value
6. Legislative skill $\geq$ some minimum value
7. Geographical project distribution = uniformity
8. Funding disposition of Office of Management and Budgeting.

The obvious differences between project formulations for, first, the technical subsystems, and second, for the larger social system provide greater appreciation for plans that somehow do not make it. In the

words of two Federal economists, "it would be foolish for an Agency whose destiny is controlled by political forces to propose solutions that leave no room for political decision" [Munger and Edwards, 1970, p. 36].

Effects and impacts. The systems-logic in Figures 2.7 and 2.8 identified the position, in the scheme of water affairs, occupied by effects, impacts, or *changes* generated by the statement of water related activities. According to this model, effects should serve as a measure of the overall system performance. This assumes special meaning when considering the requirement for environmental statements as specified by the National Environmental Policy Act of 1969 (P.L. 91-190). Subsequent guidelines for the preparation of these statements, issued by the Council on Environmental Quality [1971], offer limited assistance for this effort and fail to place in perspective the requirements of N.E.P.A. For example, if performance is to be measured by the level of satisfaction of social goals, the parameters that measure goal achievement should be selected. On the other hand, performance could be equated with the successful repression of controversy. In this case, parameters should be chosen to include those which had been sources of past controversies. This approach would measure performance in terms of social and political acceptability. The point to be made is that, seemingly, innocent impact statements also must be related to the overall conceptual order for them to provide the appropriate function within the WRM system.

Goals. Following a systems perspective and Figures 2.7 and 2.8, goals appear as an integral part of a system's operation. Usually,

at a high level of generalization this fact is reflected in the view that systems are self-maintaining or exhibit survival tendencies.

This generality does not filter down the reason why traditional planning approaches emphasize the *givenness* of certain goals or ends. Instead, the survival tendency of systems is more reflective of the conditions which Etzioni [1968] describes as characteristics of *The Active Society*:

- (1) Has the capacity to learn collectively from experience;
- (2) Is responsive to its changing membership;
- (3) Can introduce changes into its social pattern; and
- (4) Is one that is master of itself.

According to Etzioni, American society is in the process of transformation from modern to post-modern which includes a corresponding change to the characteristics listed above. These active society qualities conform very closely to definitions of "systems" behavior and lends a certain amount of support to the original presumption that societies can be viewed as "systems." The implications here concern the fact that American society is entering an *active* stage, and therefore water resources management will likewise be entering an active stage. Historically, however, water planning has been a passive exercise in that, according to Ozbekhan [1968b, p. 82], it is "primarily used to work out sequential 'programs' for meeting crises that keep succeeding each other." But, it appears inevitable, in spite of a traditional commitment to problem solving, that water resources planning will be faced with the challenge of providing active, as well as passive, intervention. This implies purposive intervention to guide and control societal activities and correspondingly increases the status and

visibility of efforts to define goals. The planning literature [Jantsch, 1968; Mayer, 1972; and Gross, 1966, 1967] reflects a substantial commitment to the inevitable necessity for *purposive* intervention, guidance, and control. With reference to water management only Bishop [1970] has given more than casual attention to this requirement by describing water both as an effect of social and economic change and as an instrument of social policy. The existence of this dual role for water introduces an important, new element into any attempt to redefine planning approaches. More advanced methods must have a built-in capability to generate purposive programs intended to guide and control social activities. Thus, the requirements of an active society to "master itself" spill over to the WRM system as an imperative for active intervention including goals research.

The Planning and Decision Subsystem

This section expands the planning and decision subsystem from Figure 2.7 and introduces additional organizing concepts at this level. There are many dimensions along which planning and decision making can be characterized. These will be described in more detail in chapters to follow. Two dimensions in particular, the decision hierarchy and time, will be described here because of their intimate relation to other concepts in this chapter.

The first dimension concerns the bipolar distinctions that exist between collective interests and individual interests, centralization and decentralization, national needs and local needs, and so on.

It is true that water as a resource should contribute to goal attainment of the collectivity as a whole; water also contributes to individual goals even when these are incompatible with social goals.

As the complexity of water problems encourages the application of more complicated and sophisticated systems techniques, decision making shifts to higher levels; this reduces the degree of local responsiveness in planning behavior. Thus, tension exists between tendencies to centralize and corresponding demands for decentralization of decision making tasks.

Local water programs are expected to conform with programs in neighboring regions as well as with some conception of national water policy. This type of interdependence also transcends water issues themselves in the sense that water must compete for public attention and support among a variety of public issues, defense, transportation, education, etc.

These conditions reflect the *tension* that exists between poles of the decision hierarchy. Moreover, it is presumed that one task of the P-D subsystem must be to resolve somehow this tension and effect a balance between extreme positions. To accomplish this might require the establishment of *field level* water planning agencies located, conceptually, somewhere between the extremes as described in Figure 2.10. This agency receives interest demands relative to local water circumstances (or develops a statement of needs from a posture of purposive intervention in return for local support). In light of these demands, which often will be conflicting, the agency proposes an array of water related activities which are submitted for review by those responsible

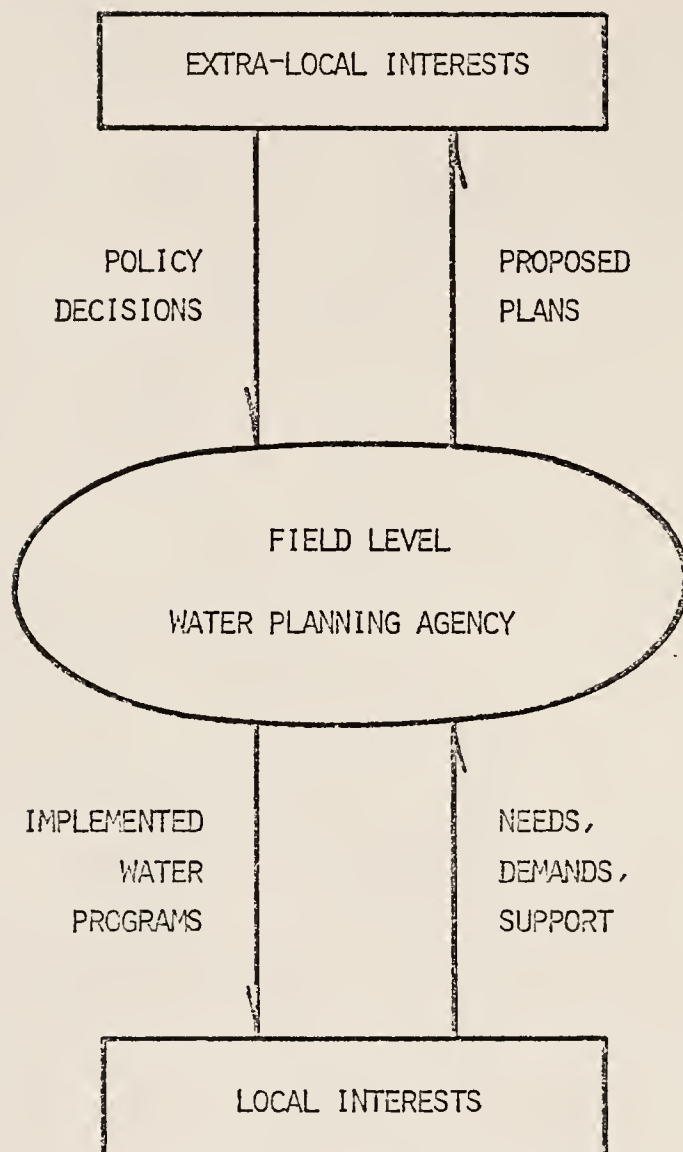


Figure 2.10. Water Resource Planning and Decision Hierarchy

for extra-local considerations. This reviewing body returns to the field level agency policy decisions relative to proposed plans which may also include recommended changes. During an earlier phase, the agency was responsible for integrating local interests into a single proposal; now the agency must consider introducing extra-local considerations as well. Finally, through some procedure as yet unspecified, the agency returns to local interests final programs for implementation.

Accepting this structure as reasonable, it next becomes necessary to establish a connection between the P-D subsystem and larger systems of interest. An earlier section accomplished this partially by describing in detail the linkages between Parsons' "polity" and "integrative subsystem." By comparing Figures 2.4 and 2.10 the parallels seem substantial between the P-D subsystem and Parsonian conceptions. Interest demands flow counter current to policy decisions; local support is exchanged for responsibility for implemented plans.

These parallels are too strong to resist. Therefore, without documentation of empirical evidence, it is presumed that the essential planning and decision functions can be associated primarily with two of the four functional subsystems as shown in Figure 2.11. Several very important implications flow from this type of representation. First of all, it identifies the primary relationships that should exist between extremes of the decision hierarchy, and between each extreme and the field level agency. Extra-local and local interests are engaged in exchanges of power and influences (which might be reflected in other symbolic media).

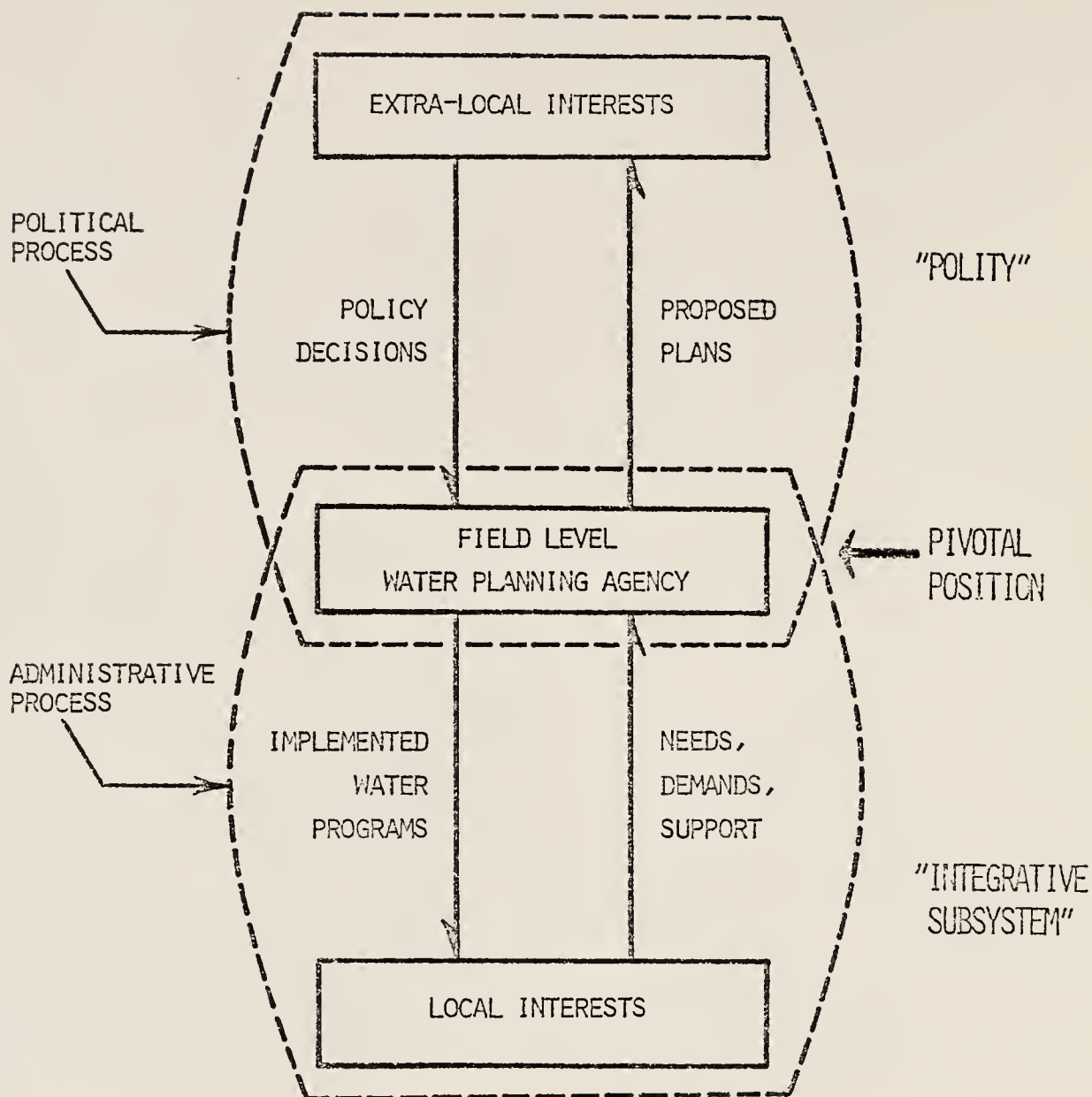


Figure 2.11. The Water Planning and Decision Subsystem Represented as Interactions Between Parsons' "Polity" and "Integrative Subsystems"

Extra-local interests and the field level agency both occupy positions in the "polity," which includes all actions concerned with the collective pursuit of collective goals [Parsons, 1966]. This provides a partial description of the functions which the agency must be able to perform. Also, local interests and the field level agency occupy the "integrative subsystem," which concerns itself with the distribution of benefits and disbenefits intended to ensure that member units support the collective effort [Parsons, 1966]. This particular relationship has immediate bearing on the visible characteristics of water programs which always result in a profile of advantages and disadvantages. Now, however, this phenomenon can be related to a set of organizing concepts which provide a means of interpreting the underlying forces in more meaningful detail.

Another useful implication concerns the role assigned to the field level agency. According to its position between these two Parsonian subsystems, the agency can be viewed as occupying a key, pivotal position in the overall P-D subsystem. It has the responsibility for double boundary exchanges between subsystems. It must engage in the assertion and satisfaction of collective goals. It must confront local value dynamics and resolve the exertion of diverse value systems through preparation of singular plans. These types of requirements do more than suggest that field level agencies need a tremendously expanded capability; they also provide very strong evidence to support the existence of a planning agency at this position in the decision hierarchy. Based on the Parsonian interchanges along with the expressed need to resolve *tensions* between extra-local and local interests, the existence

of an entity, in the middle, to handle these difficulties seems to be a necessity.

It was mentioned earlier that existing water planning activities conform closely in structure to the decision hierarchy in Figure 2.10. The organizing concepts above also have implications for these ongoing activities, as well. Foremost among these is the fact that existing planning agencies concern themselves mainly with facilities intended to satisfy certain collective goals. However, according to the General Theory of Action, facilities are provided by the "adaptive subsystem" as shown in Figure 2.2. As a review, resources intended to satisfy collective goals are useless until they are converted into the appropriate tools. In complex societies, the economy addresses the resource-conversion problem by providing the multitude of products, services, etc., used in goal attainment. With the WRM system, existing agencies convert resources into facilities and thereby serve as the "economy" at *this* systems level. The point to be made here is that primary emphasis has been given to facilities conversion, whereas, according to Figure 2.11 primary emphasis is required between other functional subsystems. Thus, it becomes clearer how a set of organizing concepts like this can begin to reveal problems, identify inadequacies, and suggest more appropriate directions.

These brief sections only touch the surface relative to the organizational powers of systemic descriptions of social action. However, certain weaknesses also exist. One that comes readily to mind would be the difficulty in making this portrayal of stocks and flows operational. Although one can accept the categorization of various

functions in concept, how might they be tested, modified, and controlled in a planning context? Another difficulty arises from the fact that the Parsonian scheme emphasizes taxonomy or the compartmentalization of functions, variables, etc. Because of this tendency, the framework lacks a substantive content and cannot easily explain concrete, observable phenomena, even though these events may be categorized. Other difficulties surround the basic presumption that system maintenance is the prime goal. This starting point biases observations in favor of the status quo and against the individual. If something is dysfunctional or if something encourages change, the systemic concept would tend to view it as bad. In water management, for example, changes in requirements and values frequently occur along with various levels of conflict. By relying solely on concepts presented in previous paragraphs the WRM system would react as if these phenomena were disruptive or were eccentricities. However, as previously explained, the purpose has been to establish a conceptual framework for water management which can respond productively to the dynamics of the social overlayer. Thus, additional structure will be required to overcome these difficulties.

In an earlier paragraph, the planning and decision subsystem was cast primarily within two Parsonian units. This means that the P-D subsystem focuses primarily on goal-attainment for the collectivity *along with* the distribution of benefits and disbenefits among its members. Redefinition of water management in this way introduces a strong political flavor similar to the approach taken by Froman [1962, p. 4], "Politics in its broadest sense, is concerned with the distribution of advantages and disadvantages among people." Such a definition places

decision making in a central position since distribution or allocation among parties in conflict depends upon (1) the type of decision making process, and (2) the actors involved [Froman, 1962]. Fortunately, this more detailed view also helps overcome difficulties inherent in the Parsonian structure. First, the decision making approach represents a dynamic, process-focused analysis which expands the static, snapshot qualities inherent in the General Theory of Action. Second, decision analysis requires an examination of the actors involved and would tend to shift the imbalance which exists in Parsonian conceptions more towards the individual. Third, but not last, the acceptance of the *decision* as a basic unit of analysis allows one to operationalize an examination of phenomena in various subsystems, and to explain concrete, real-world observations. In a very loose sense, then, these additional concepts will allow us to "fill in" detail within the general, more encompassing systems framework and to relate this more directly to water management.

Thus, we turn now to the second dimension of the P-D subsystem, *time*; planning and management have meaning over time which is revealed by this focus on decision making. Snyder [1958] and Froman [1962] carry this idea a step further by identifying two important factors, the type of decision making process and the actors involved. Clark [1968] and Miller [1972] have related these factors specifically to community interactions by defining the *decision making structure* as the process or pattern of influence exercised over time and the *power structure* as the patterned distribution of power over actors. This connection to community decision studies suggests that organizing concepts relative to the

time dimension might well be taken from that body of literature.

Indeed, over the last two decades a wealth of information has accumulated in this area and will be reviewed in a later chapter. (Hawley and Wirt [1968] in *The Search for Community Power* and Clark [1968] in *Community Structure and Decision Making* provide excellent overviews.)

To this point in the discussion, the general overarching framework for water management has been provided by Parsonian concepts. Operational detail has been introduced by those concepts and theories which evolved from studies of decision making. Thus, it will be useful here to identify certain salient features of the planning trajectory as they relate to time-based concepts. A portrayal of these attributes appears in Figure 2.12 which attempts to identify several functional processes important to planning. These might include plan formulation, value resolution, evaluation, implementation, and others which evolve over time along with the social decision process. For illustration, the major steps in a typical Corps of Engineer project [James and Lee, 1971] have been plotted in parallel. Thus, planners encounter various decision phases characterized by different combinations of functional processes. All have to be faced and should be faced consciously and explicitly. However, several questions arise. Should specialized systems be used which concentrate on each separate process? Should all processes be included in a unified approach with only a mode shift from phase to phase? Answers to these types of questions as yet do not exist, but again, assistance can be sought in the literature on collective or community decision making. For example, Rogers [1970, 1971] identifies five phases for any "collective innovation" decision process:

TRAJECTORY OF THE SOCIAL DECISION PROCESS

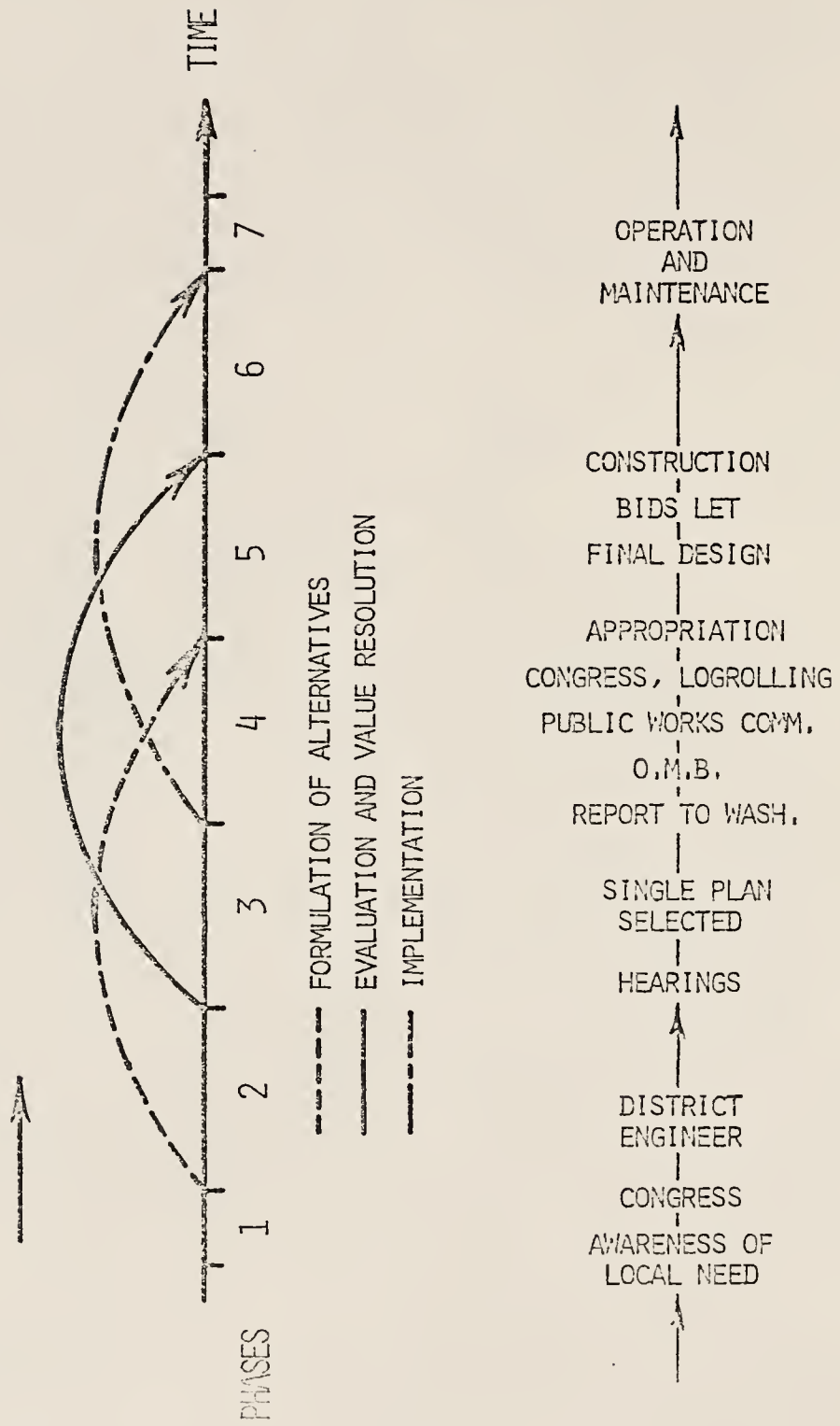


Figure 2.12. Influence of Time in the Social Decision Process

stimulation, initiation, legitimation, decision, and action. Agger *et al.* [1964] and Nuttall *et al.* [1968] provide expanded models of these decision making activities. Each paradigm of this type will usually provide, as well, the actors and processes appropriate to each phase or step. Although such studies of community or collective processes may themselves be in evolutionary stages, the potential for synthesis exists and should be capitalized upon.

The Chapter in Perspective

Be it ever so treacherous, the social system is the *only* media through which we can actualize our individual and collective needs. The formulation of particular courses of action, especially technical plans, with indifference to this actualizing media cannot hold much promise for dealing with incipient problems. Preceding sections addressed this difficulty and, in general, specified the need for a Conjoint Planning Approach (Figure 2.13) where formulation, implementation, and social decision making blend together in an intimate, interactive manner. These remarks also attempted to supply a minimal amount of structural integrity to enhance the accomplishment of this objective.

Within the scope of conjoint planning, the following chapters represent an attempt to solve the *general water resource decision problem*:

Select a single plan for implementation from numerous alternative plans, when each alternative would produce a different set of environmental, economic, and social impacts.

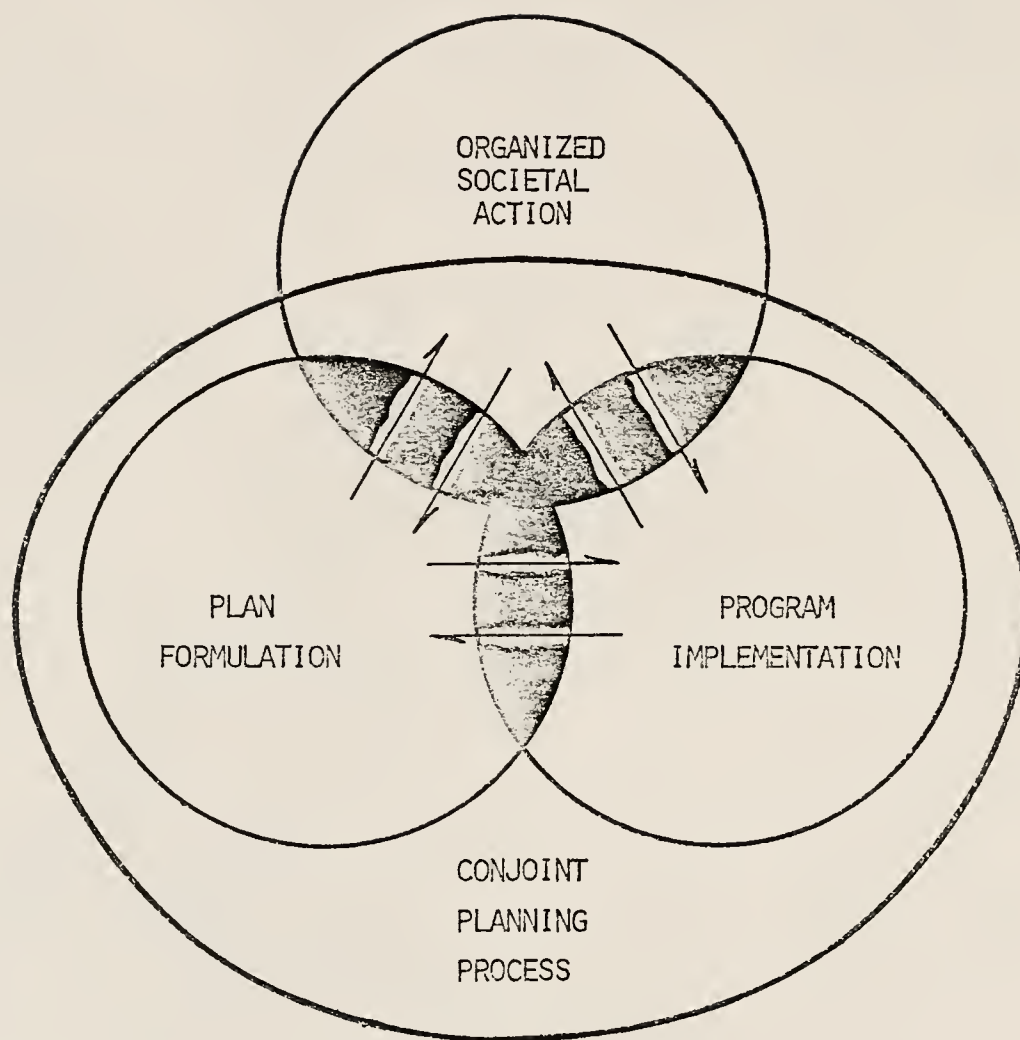


Figure 2.13. Components of the Conjoint Planning Process

This general statement is intended to include sets of "good" plans, the requirement to select one, the need for implementation or an action focus, no specification of decision maker(s), and the existence of value dynamics. Remaining chapters, in the context of foregoing sections, can be viewed as an attempt to solve this generalized problem.

CHAPTER III

PLANNING THEORY AND WATER RESOURCES MANAGEMENT

The particular situation . . . in which we find ourselves today, is characterized by the necessity for planning on the one hand, and by the reluctance of the [social] system to accept planning on the other. This paradox seems to be a basic feature of the majority of social systems today.

--Erich Jantsch [1968, p. 19]

Introduction

The previous chapter, starting with the existence of disorder in our perceptions of the societal envelope, concentrated mainly on several concepts which begin to introduce order and structure into this overlayer. This initial effort reflects the fundamental strategy that, first, it is necessary to investigate the next-larger system to give meaning to the analysis of any subunits. To do otherwise would neglect the controlling influence exerted by larger systems and would reduce the chance of considering interactions moderated by the overlayer. Thus, foregoing sections provided structural detail for the social system, moved next to the water management system, and then introduced planning in rather nonspecific terms. The primary intent was to reorient water management and bring its foundations more in line with existing theories of social action. Sections to follow begin to focus on planning as a specific activity to insure that planning fits

with the more embracing concepts presented earlier and to introduce planning concepts into the void existing in water management.

It will become apparent as sections unfold that theories of planning are less developed than the theoretical perspectives on social action. In fact, planning theorists have started to recognize the need for fundamental theories only within the last decade. Ozbekhan [1968b, p. 47] feels that

planning is enjoying its vogue without benefit either of a supporting framework of ideas intrinsic to it or even of a small piece of theoretical ground it can claim as its own--something . . . on whose soil one might hope to grow . . . those operationally verifiable methodologies, . . . that most other serious disciplines possess.

Sections to follow, which begin to introduce these concepts, draw heavily upon Ozbekhan's [1968] *Toward a General Theory of Planning* and Friedmann's [1967] *A Conceptual Model for the Analysis of Planning Behavior*.

Planning as a Universal Concept

The second law of thermodynamics reveals that the world is continually falling into disorder. This universal law suggests that, in time, everything will be reduced to a low-energy, randomized, homogeneous soup. In its most general terms planning can be viewed as the effort to mobilize and concentrate energy, the attempt to introduce structure, and thus the reversal of the natural increase of entropy. However, a problem arises when the balance must be struck between too little and too much structure. Natural systems seem to perform this delicate task quite well; human systems often fail by providing

too much structure, for example, the over-bureaucratization of societies, massive cities, massive water projects, and so on. According to Dakin [1963, p. 23], "Planning can therefore be understood as a careful balance between efforts to draw energies together. . . . Planning is the holding of the balance."

To be more specific, planning is a human social activity whose function is to reduce entropy and increase organization within an environment. Furthermore, planning springs from the human mind which can visualize past, present, and future, can project an image that the course of events can be made better, and believes that planning can accomplish what nonplanning cannot. Therefore, in contrast to the activities of nonliving and nonhuman systems, planning represents a conscious, deliberate, voluntary intervention into natural and social environments to enhance a balanced, steady state (in entropy terms) and to ensure harmony between planning and its larger systems.

As an aside, it is interesting to note that planners in particular recognize the entropic implications of human planning activities and the requirement that human beings relate harmoniously with their total surroundings. In a separate field, ecologists for years have emphasized that natural systems continually "track" that point of harmony by building structure in a way that maximizes energy flows [Odum and Pinkerton, 1955]. Furthermore, in natural systems there often exists an organism called an ecosystem manager that utilizes a small fraction of the total energy budget and in return provides a service which aids the system in its function and continued survival [Lugo and Snedaker, 1971]. These parallels between phenomena observed

in the natural system and the role suggested for planning, as identified by planners, are complementary and very seductive. In fact, they lead one to believe that human activities should not be called "planning" unless they are supported by the same guiding principles which establish the relations between all living things and their surroundings. For urban planning specifically, one such effort has been made by an ecologist to incorporate entropic phenomena into the planning regime for a Florida community [Odum *et al.*, 1972]. The effectiveness of this planning effort is not yet available. However, it does represent a significant attempt to use certain universal laws as a guide for local land use planning. In this way, it brings planning more in line with a set of organizing concepts and portends the direction in which water resource planning should move.

Planning as a General Concept

Talcott Parsons developed the General Theory of Action which would apply to any social system. A similar thrust is reflected in the contemporary planning literature which recognizes the need for general theory of planning. As such theories become available, the earlier fragmented approaches to land use planning, urban planning, natural resource planning, etc., will then be able to draw upon a cohesive set of organizing principles. A general theory will also define the appropriate relationships that should exist between planning and other systems within the social sphere. Thus, a strong similarity exists between the strategy of the previous chapter and the remarks to follow.

Actually, this portrayal of planning characteristics represents an extension of previous concepts focusing on the planning component of the Planning and Decision Subsystem. But first, we need to identify those fundamental requirements to be satisfied by a general theory of planning. Dakin's [1963] *An Evaluation of the "Choice" Theory of Planning* provides considerable guidance in this effort:

- (1) *Must be universal.* The general theory must hold for all kinds of planning from corporate, to military and public. Common elements exist in all kinds of planning, and it would be essential to capitalize on these similarities;
- (2) *Total planning process must be included.* Planning is not a static or snap-shot phenomenon. Instead, it adheres to a line of action or trajectory. This requirement conforms well with the component time, introduced earlier;
- (3) *Must not depend on a particular political system.* A requirement like this will be more difficult to satisfy. Parsons' general theory of action has no orientation to any political philosophy, however, it was applied to water management in a federal context. Planning concepts will be related to the same context. This is politically suggestive although specific governmental forms were not introduced;
- (4) *Must be related to physical and social theory.* Planning, like everything else cannot ignore those laws which govern the functioning of nature and society. Previous remarks related to laws of entropy and fundamental social dynamics begin to establish planning in this context; and
- (5) *Must account for non-rational elements.* Planning is for and because of people. Our focus must expand from rational manipulation of things such as car trips, miles of channel, etc., to include new emphases and to involve behavioral characteristics such as tastes, attitude, values, and so on. As Dakin [1966, p. 24] puts it, "the non-rational element in men cannot be omitted either as a fact of human society . . . , or as a value. . . . Man is a whole--rational and non-rational--and he *plans* [emphasis added] as a whole being."

Using these requirements as a guide, rudimentary components of a general planning theory can be assembled. Only the essential structures appear here. Ozbekhan [1968b], who also performed extensive

philosophical and epistemological spadework, should be consulted for finer details. (For example, he defines "evaluation" and "futures," their precise relation to planning, and the complex parts they contain. It turns out that these and similar terms require much more careful attention than they receive today.) It came as a slight surprise that Ozbekhan used the notion of system as his central theoretical construct. This notion not only supports concepts presented in the previous chapter, which were based on a systems perspective, it also allows the planning and general action theories to be bridged in a consistent manner.

To begin, planning is embedded in an *environment* which planning acts on to establish a long-lasting consonance between the human being and this environment. Furthermore, this generalized environment can be recast into subsystems (Figure 3.1) which relate more directly to concepts in the previous chapter. Start first with the total *biosphere* as the largest system worth considering. Next, any planning effort will have associated with it an interactive *natural and social system* which are changed by planning. Then, since planning as a purposive human activity takes place within a social context, it follows that a *social decision system* must be considered. Finally, the *planning system*, along with its own subsystems, falls within the range of control of higher units. By focusing on the planning system for analysis, the diagram in Figure 3.1 establishes the exact systems hierarchy of control and in this way identifies the position for planning in the total scheme of things. Concepts from the previous chapter did not specify precisely how planning was related to other units, as is shown in the following:

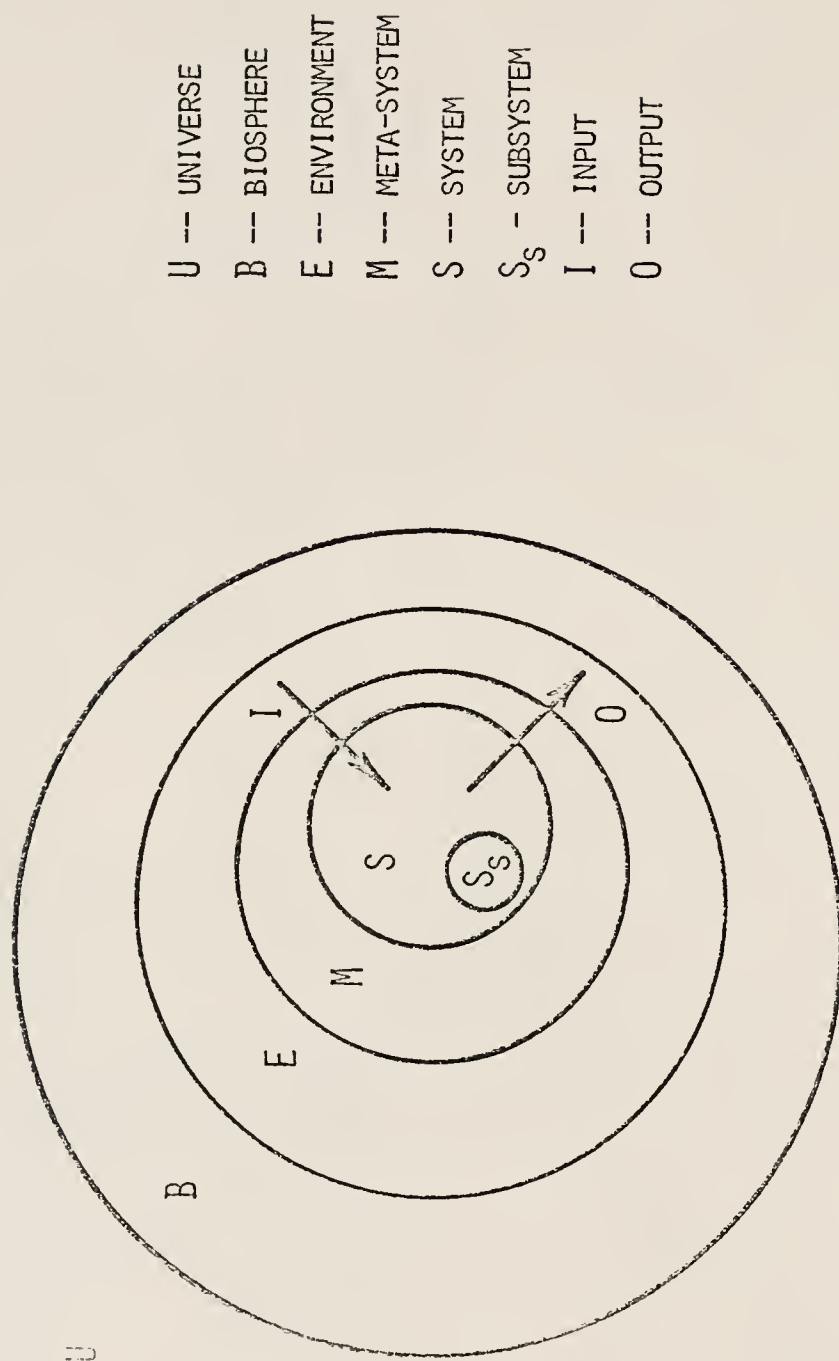


Figure 3.1. Hierarchy of Systems
 (Adapted from Ozbekhan, 1968)

S_s - *subsystem*, within the planning system

S - *system*, planning system

M - *meta-system* next larger, social decision system

E - *environment*, natural and social planning environment

B - *biosphere*, beyond discourse

U - *universe*, beyond discourse.

Many previous remarks fall now into clearer focus. From Chapter I, the changing external context, i.e., the external planning environment (E), has been defined as natural and social milieu, the largest system of interest to the planning system itself. This environment (E) becomes the source of planning inputs (I) defined as any event occurring in the environment (E) that alters the system (S) [Ozbekhan, 1968b]. Within (E) there exists a social decision system (M) which provides the bridge between E and S . Finally, inputs reach the planning system (S) which, using its subsystems (S_s), converts these into outputs (O) defined as any *change* produced in the environment by the planning system [Ozbekhan, 1968]. Ozbekhan should be consulted for more detailed discussion of various related factors such as environment, boundaries, input and output, open and closed systems, feedback, human systems, control, and others. These main ideas were abstracted here to provide the missing definition of planning relative to earlier remarks.

Planning as a Specific Concept

It was important to identify the position of planning in the envelope of social action, however, additional detail on planning subsystems (S_s) will have more immediate relevance to water management. This, too, will represent an extension of ideas initiated in Chapter II. Two components of planning activities, the decision hierarchy and time, were used there to fill in open spaces in the General Theory of Action. Here, gaps in this general planning theory will be structured by using a third component, the *planning task* hierarchy. Behind this third dimension lies the requirements for certain task levels ranging from policy-making to technical design. Burke *et al.* [1972c] have advanced this concept earlier, however, an elaboration will be required here to set the stage for the more detailed investigation of planning subsystems.

Policy Choice vs Design Choice

First, define policy-making as the setting of courses of action designed to implement the values, usually of a fairly large group of persons, on a given issue without unduly compromising other's values on other issues [Bauer and Gergen, 1968]. Policy can take at least two forms; first, decision rules adopted by authorities to guide behavior of subordinates, and second, more general intentions of authorities, not binding on subordinates, of which *any specific output may be a partial expression* [Easton, 1965]. As such, policy represents an expression of the tradeoffs among value systems which have the widest ramifications and the longest time perspective. Thus, and this is an important point, *each water plan contains within it an expression*

of policy. Diverse value systems must be accommodated, widespread ramifications are always involved, and long planning horizons are used. Or, as Ozbekhan [1968b, p. 74] states, "plans are in fact policies." The point to be made here is that plans and planning are inextricably related to policy and policy-making. Yet, the procedures we now call planning pay little, if any, overt attention to policy-making per se. Instead, primary emphasis falls on design choices (the relation of various means to given ends), and policy-making responsibility flows to separate environmental (E) units. Ozbekhan provides a revealing explanation of the logical and real-world consequences that flow from this persistent rupture between policy-making (the comparison of ends vs ends) and design (the comparison of means vs ends). Leaving these details to him, the conclusion to be advanced is that planning, referring to a general theory of planning, must be able to account for policy-making activities as an integral part of the conscious intervention into environment (E) for the purpose of changing it. It seems necessary, then, to view planning not as the servant of policy-making but as the larger structure of decision and action processes of which policy-making is an intimate part.

The Language of Planning

Expansion of the planning sphere to include policy-making reflects an evolutionary trend in planning thought from more mechanistic approaches to this enlightened version. However, in everyday affairs the mechanistic or orthodox model prevails and with the following characteristics:

- (1) Policy and goals are viewed as *given* from outside;
- (2) Model is designed for programmed *problem-solving*;
- (3) Activities focus on specific class of problems and emphasize *means* rather than *ends*; and
- (4) Control is affected by *positive* feedback which amplifies rather than moderates certain types of action.

Planning like other systems must, therefore, develop specialized subsystems to address various functional requisites spanning (1) norm seeking, (2) goal setting, and (3) action. Moreover, these subsystems must stand in a hierarchical relationship to each other connected by certain controls and flows. The following specifications, adapted from Ozbekhan [1968b], form the basis of a *language of planning* which begins to add substance to relations among planning subsystems (Figure 3.2).

- (1) Planning is a complex, dynamic system whose function is to affect *changes* in its environment;
- (2) Planning has a structure composed of a three-level hierarchy:
 - (a) An *operational* level which is mechanistic;
 - (b) A *strategic* level which, because of goals and values, is causative of action;
 - (c) A *normative* level which contains value dynamics;
- (3) Planning operates under two types of controls:
 - (a) Controls within and between each level;
 - (b) Controls between the environment (E) and planning (S);
- (4) These controls are themselves positioned in a hierarchy:
 - (a) The normative level receives functional needs from below and returns boundaries and guidance for action;
 - (b) The strategic level needs mechanics from below and returns boundaries while operating within constraints from the higher level;
 - (c) The operational level, constrained from above, received inputs from the environment (E) and returns services which produce changes;

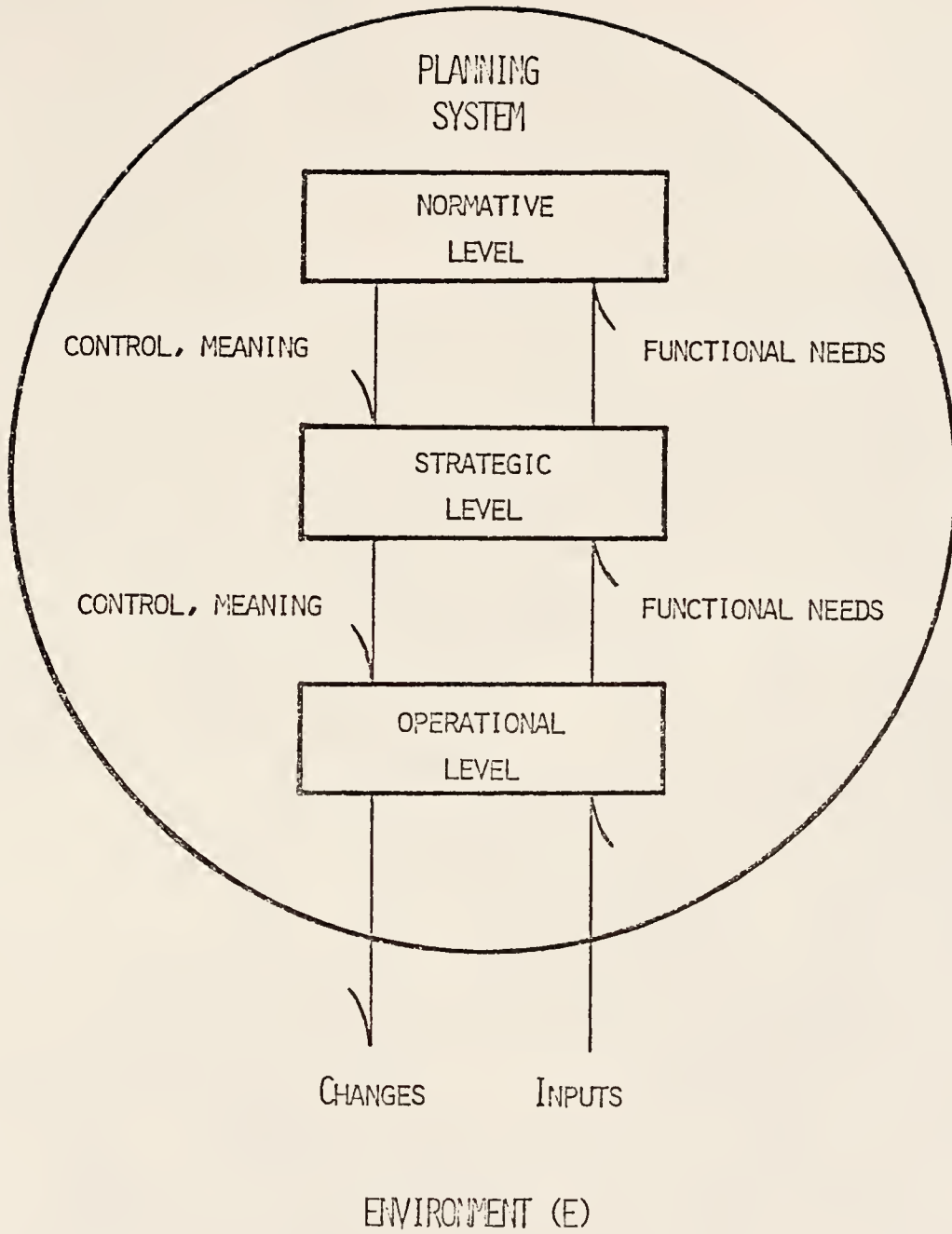


Figure 3.2. Planning's Hierarchical Subsystems

- (5) *Control* and *meaning* move downward to the most concrete environmental elements and produce change;
- (6) The fundamental problem in planning is the transformation of meaning from the normative level across the inner boundaries of planning subsystems to the environment;
- (7) Flows cannot take place in reverse. Meaning cannot be *arbitrarily* ascribed to operational plans then translated upward into strategies and norms. In general, content and operations at any given level cannot be deduced from principles governing at a lower level. The vertical, hierarchical organization prevents this.

Hierarchy of Planning Tasks

This language of planning, then, defines another critical dimension to the water resource management problem in addition to the decision hierarchy and time. It is important to emphasize that the task hierarchy does not conform necessarily to the bipolar decision hierarchy described in Figure 2.10. Since we commonly look to extra-local interests for policy statements, it would be an easy mistake to presume normative planning resides there as well. However, policy statements may come from both extremes and the middle of the decision hierarchy. Thus, the task hierarchy may be viewed as a continuum along another dimension superimposed over Figure 2.10. Similarly, it would be misleading to view the planning tasks as falling into an organized time sequence. True, there must be a certain degree of lag between tasks, since values need to be resolved before extensive commitment falls to design efforts. However, time sequencing has little meaning relative to the task hierarchy because of a general and substantial overlap between levels with respect to time. The orientation of various tasks compared to conjoint planning approaches appears in

Figure 3.3. This provides a better perspective on planning subsystems which can be viewed as bridging mechanisms for planning processes that do have meaning over time.

Also, as was mentioned earlier, planning serves to concentrate diffused societal energy into a specific course of action. The task hierarchy exerts primary influence in this activity since it acts as a dynamic filtering mechanism. A broad range of futures and value systems interact at the normative level, however, the ever-increasing vertical control narrows and filters available actions until planning energy focuses into a single line of action. Another useful way of looking at this characteristic is in terms of environmental (E) events and the way planning (S) reacts to these events. Ozbekhan [1968b] describes two reasons why we look at environmental events or inputs (I): first, to acquire knowledge about their nature, and second, to use knowledge gained. Viewed in this way, the planning hierarchy must be able to receive factual information observed without value judgement. But, in order to make decisions these facts interact with value judgements. Thus, between planning inputs and outputs, the task hierarchy must blend facts and values in terms of action. To describe these relationships more precisely each task level will be expanded briefly:

Normative level. The realization that norm-seeking should be an integral part of planning served as the rationale for introducing this level into the task hierarchy. Earlier, values and norms were described as those conceptions of desirable states or behavior that can serve as criteria for choice. Since it would be difficult to conceive of planning circumstances where no guides or criteria for

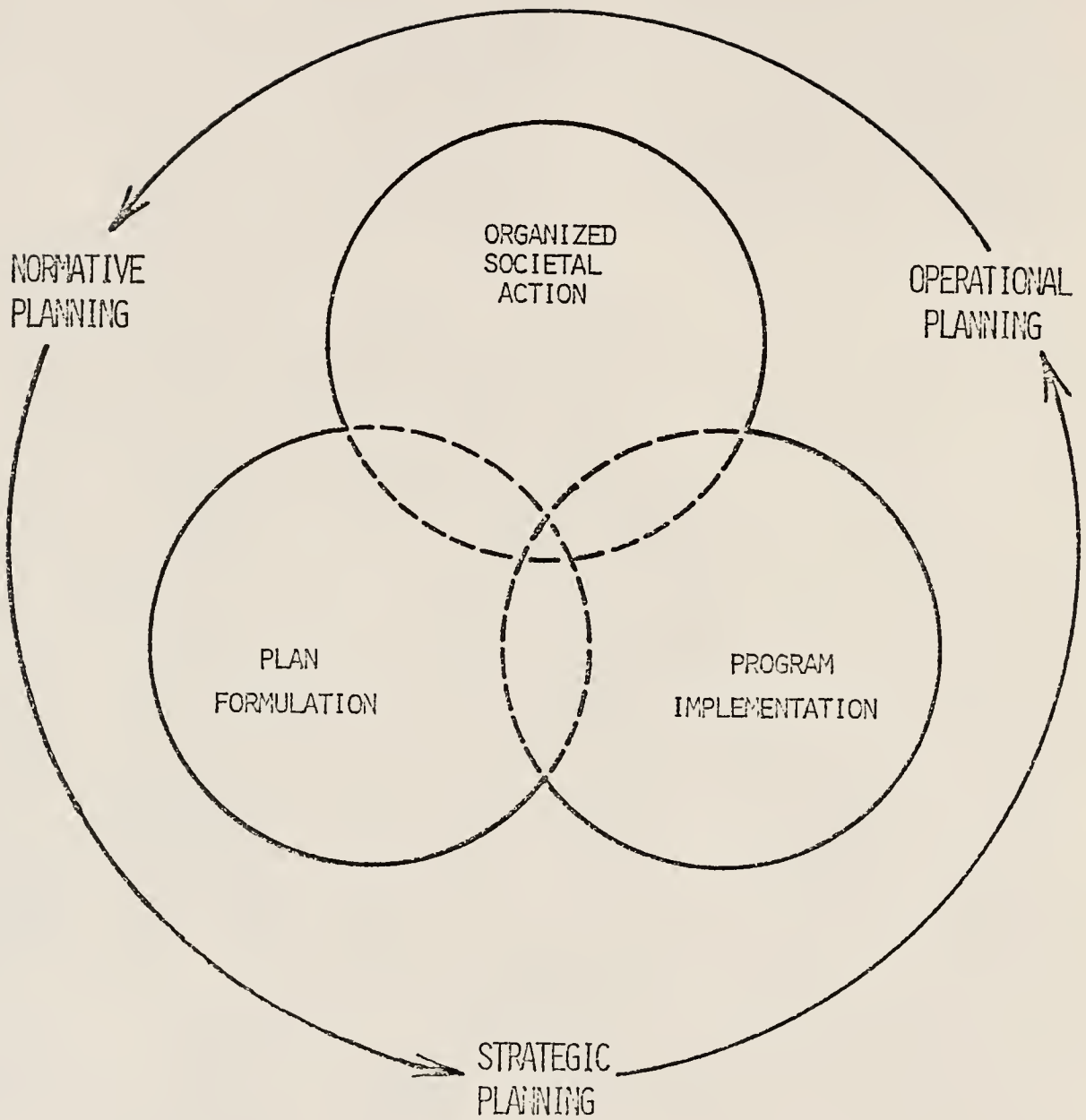


Figure 3.3. Conjoint Planning and the Task Hierarchy

choice were needed, it becomes necessary to address the problem of value dynamics or norm-seeking. In fact, the *resolution of diverse value systems* can be viewed as the first-order problem in water resource management. Even considering scientific advances and improvements in technology, the task of reconciling a great diversity of interests and values will still remain as the central issue. For, as Caldwell [1971, p. 20] states, "it seems doubtful if scientists alone will be able to determine the environmental conditions that people will seek. There will still remain an element of personal preference. . . ." Thus, in all of our planning efforts there must exist a normative level where values and futures interact, fed by functional requirements from below which then returns control to lower subsystems as conceptions of what "ought" to be done. In the past this function has been performed in a fragmented, indirect manner resembling the way in which closed systems operate [Ozbekhan, 1968b]. However, it has been a contention since the beginning of this report, that diverse value systems must be provided room for free interplay and that these interactions should dominate in the selection of overall plan configurations. The task hierarchy begins to establish this type of process "pecking order."

Strategic level. Interactions at the normative level will produce various conceptions of what "ought" to be done which then give meaning to lower level functions. Thus, strategic planning absorbs policy generated from above and begins to filter normative options in terms of whether they can actually do the job or not. That which "can" be done must always refer to a particular number of alternatives from above, not some notion of expediency which later will be related to

controlling norms. Strategic planning includes objective-setting, the formulation of strategies for effective action, an investigation of tradeoffs among various objective sets, and in general a determination of what can be done to satisfy the given policy. Water resource management activities traditionally include these types of strategic operations, in contrast to the lack of attention paid to normative requirements, however, they do not take place within an effective organizing framework. It seems necessary, then, to capitalize on the existing visibility of these strategic functions by placing them within an effective relational structure such as the task hierarchy.

Operational level. At this point, it should be recalled that tasks in this hierarchy do not fall into any rigid time sequence. Actually, by the time the operational level raises to full operation there may have occurred numerous communications between task levels and between planning (S) and the environment (E). In any event, this level receives inputs from the environment, refers its functional needs to higher levels, receives meaning and guidance from higher units, and then translates these requirements into statements of water related activities which change the environment. Planning as we recognize it today, earlier called mechanistic planning, falls primarily into this operational category and determines what "will" be done in light of what "ought" and "can" be done as specified from above. Emphasis here focuses on problem solving, means rather than ends, technical details, and implementation.

As with strategic operations, functions at this level are very familiar to water managers, however, in the present context, field level [Hufschmidt, 1965] or operational planning do not relate to any cohesive structure. Those essential functions, which would be addressed by the entire task hierarchy, still remain to be performed. But, in the absence of specific planning subsystems (S_s) to take up these requirements various unrelated systems move in to fill the void. This type of phenomena accounts for much of the confusion and frustration evident in contemporary water management.

The "Linkage" Between (S) and (E)

Earlier, Friedmann's [1971] identification of the need for a linkage of scientific intelligence and societal action served as the spark for analyses in this and the preceding chapter. First, beginning with a unstructured social system successive levels of definitions were advanced until planning and decision making could be identified relative to other parts of the social structure. At that point, planning had little substance and along with decision making was conceived only to flesh out the social envelope, now called (E) in Figure 3.1. This chapter began with planning (S) as the basic unit of analysis and added definitions, in terms of subsystems (S_s), until planning itself could claim substance of its own. Still missing, however, is the precise linkage between (S) and (E), which by the definition of planning must exist in some form. Various sections, along with Figure 3.1, have described, in general, the nature of this linking mechanism, but more specific identification is required before the general water resource problem can be properly faced.

Simply stated, the *decision making system* shown as (M) the meta-system in Figure 3.1 provides the mechanism for linking scientific intelligence plus planning (S) to the natural and social milieu (E). In Etzioni's [1968, p. 250] words,

It is, thus, mainly through the decision making processes that vague and abstract societal commitments, whose directions are indicated by the values and goals to which the actor subscribes, are translated into specific commitments to one or more specific courses of action.

The flow diagram in Figure 3.4 begins to describe this pivotal role exercised by decision making between generalized commitments and specific courses of action. However, although simple to state, this specification can be deceptive in its simplicity. Decision making, as we shall see later, assumes a complex variety of shapes and forms, for example, decisions may be the responsibility of single individuals, or, on the other hand, may require a collection of interacting people. Referring to Figure 3.1, individual decisions may originate in planning subsystems (S_g) and eventually blend with collective action taking place in the social decision system (M). Thus, even along a single characteristic of individual vs collective action, the precise nature of this linking mechanism would be difficult to determine. Add to this numerous other components which also characterize different types of decisions and the situation becomes very complex.

Bolan [1969] begins to identify these relationships by casting the planning process within a "cultural envelope," similar to models of community decision making mentioned in Chapter II. Ozbekhan [1968b, p. 154] adds, "Power is at the heart of every argument with which planning is concerned." This introduces a new dimension into contemporary

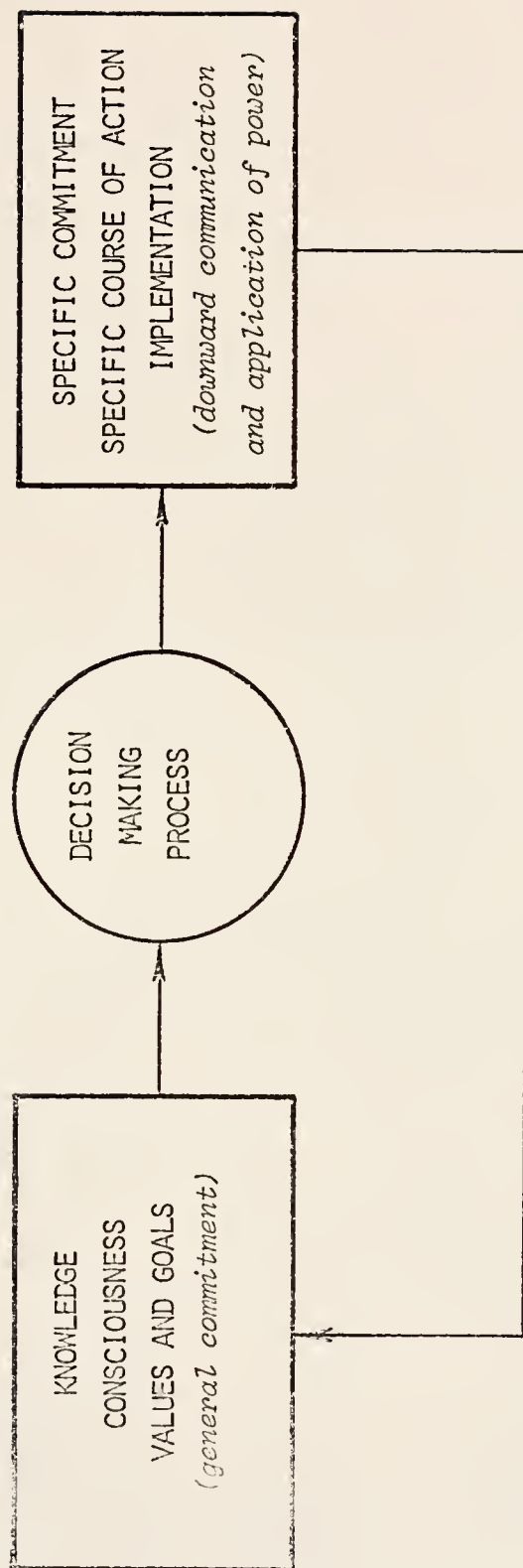


Figure 3.4. Pivotal Role of the Decision-Making Processes
(Adapted from Etzioni, 1968)

planning as it is presently conceived, yet it conforms well with the three components, decision hierarchy, time, and task hierarchy. For example, Etzioni [1968, p. 314] has stated clearly how power must be considered as that force which overcomes social "friction":

the realization of societal goals requires introducing a change into societal relations, either in the societal environment or among the member units, and, as a rule, attempts to introduce changes . . . encounter some resistance. Unless this resistance is reduced, a course of action set will not be a course of action followed. *Power is the capacity to overcome part or all of the resistance, to introduce changes in the face of opposition.*

The point to be made from all this is that the *decision*, in all its various forms, can be used as a common denominator for studying various problems including the general water resource decision problem mentioned earlier. Trouble spots can be characterized in terms of decision inadequacies; remedial measures can be defined in terms of various decision models. The use of power in social decision making can be related to individual deliberations within particular planning subsystems through the decision hierarchy, task hierarchy, and time. Thus, we should be able to turn our attention away from other complexities and focus on the decision as a means of addressing water management difficulties.

CHAPTER IV

THEORIES OF DECISION MAKING AND WATER RESOURCES MANAGEMENT

There seems to be no one decision strategy in the abstract, apart from the societal environment into which it is introduced.

--Amitai Etzioni [1967, p. 391]

Problems of social choice will not vanish merely because the tools available to handle them are declared to be imperfect.

--William Vickrey [1960, p. 535]

To Establish a Linkage

An underlying premise of the previous chapters has been that a disparity exists between requirements exerted by the external environment and the capabilities of current procedures for meeting these requirements. It was further suggested that to deal with this disparity and its frustrating consequences would require an explicit, intimate *linkage* between planning activities and the societal overlayer. Although the exact nature of this linkage is not (and may never be) known, there is a compelling need to explore its features. Otherwise, disruptive influences beyond our control and exceeding our capacities to manage them will continue to flow into the planning sphere. For this reason, the foregoing chapters began an exploration of the planning environment

not so much to propose a general theory but instead to offer some guiding principles and concepts to stimulate further consideration of this elusive linkage.

Even though it is not clear that societal affairs can be treated as "systems" [Buckley, 1968; Faludi, 1973; McDougall, 1973; Chadwick, 1971; McLoughlin, 1969], a systems perspective was adopted for this research because of its organizational powers. For example, Figure 3.1 (p. 85) contains a hierarchy of systems, relevant to water management, which begins to establish a location for the linking mechanism. The universe (U) and the complete biosphere (B) for most purposes are beyond discourse. Instead, the first system which impinges onto planning efforts would be the environment (E) containing natural and social phenomena *changed* (potentially) by water management activities. Next, skipping to the interior of Figure 3.1, the planning system (S) is shown as the source of *outputs* to the environment in the form of water-related activities that may produce changes in (E). These outputs are a reflection of *inputs* from (E) expressed as needs and demands for planning action. The points to be made from this schema is that a gap exists between the relevant environment (E) and planning systems (S). Diagrammatically a meta-system fills this gap and, for this study, will be identified as the social decision subsystem within the total societal overlayer. Hence, meta-system (M) controls and moderates planning activities and at the same time provides the requisite linkage between (E) and (S). "Seen in this way, planning is not an isolated or self-contained operation but is a recognizable part or function of the social

process manifesting itself in many different but identifiable ways" [Dakin, 1963, p. 26].

The rudimentary organization provided by Figure 3.1 begins to reveal several places where one might focus attention during further analysis. However, first it becomes necessary to distinguish between *substance* and *process* or, in line with previous discussion, between the *substantive* and *operative* planning contexts. The first concerns structure and form, while the latter relates to action over time. Crudely put, substance might answer questions who, what, and where, leaving when, why, and how for operative analysis.

Figure 4.1 contains a 2-way typology for these components as they relate to the natural and social systems within the environment (E). Traditionally, our attention has focused on block A-I containing physical features, man-made structures, and so on. More recently, because of "ecology," block A-II has become increasingly visible as complex ecological interactions over time generate consequences for planning and management. However, blocks B-I and B-II likewise generate consequences for planning and deserve no less than equal attention.

Froman [1962, p. 6], in a political context, identified this distinction between substance and process as the concern with (1) people and the payoffs they receive along with (2) the decision making process involved in the distribution of payoffs. This same process emphasis, described by Froman, began to surface in the planning literature in the early to mid-1960s. For example, Dakin observed that planning must be able to embrace the intractable fact that human affairs are always in

flux. To this end, ". . . [planning] theory would need to be correlated very closely with theories dealing with the nature and functioning of human societies, since the actions which are planning take place within the social context and not outside it" [Dakin, 1963, p. 26]. A bit later, other planning theorists probed more deeply into *process* as a critical dimension in planning activities [Webber, 1965; Bolan, 1967, 1969; Friedmann, 1969]. Friedmann, in particular, remarked that, "The problem is no longer how to make decisions more 'rational,' but how to improve the *quality of the action*" [1969, p. 311]. He continued to elaborate on the ". . . growing recognition that planning must move closer to action," through his statement that "the common denominator of all effective planning is that planning must be 'actionable' and as such must be an integral part of an organization's decision making and managerial processes. . ." [Friedmann, 1969, p. 312].

Only recently has this reorientation of planning focus penetrated the public works field. In this instance, Manheim [1972], while studying the effects of alternative transportation policies, viewed the overall problem as "continuously evolving" and recommended a "process strategy" for its resolution. Briefly, his process approach views as fundamentally important (1) the total set of effects on all groups "with particular attention paid to the differential effects, which groups gain, which lose" [p. 4] and (2) "the process through which a variety of public and private institutions, interest groups, and individuals will interact to reach a decision" [p. 7].

The process or action focus, then, is more firmly established in urban planning than in natural resource or public works planning.

Few others besides Manheim [1972] and Bishop *et al.* [1969] in transportation, and Bishop [1970] in water resources recommend a specific process approach. Block B-I, the substantive social context, has received a bit more attention in water planning through interest group identification [Sheaffer *et al.*, 1970], public participation studies [Borton *et al.*, 1970; Warner, 1971], distribution of project effects [Bromley *et al.*, 1971], and analyses of organizational arrangements [Ostrom, 1971a, 1971b] as a few examples. Yet, even considering these efforts one might agree to the following summary, based on Figure 4.1, concerning the state-of-the-art for a holistic perspective in water planning:

<u>Category</u>	<u>Status</u>
A. <i>Natural System</i>	
I. Substantive Context . . .	Established Efforts
II. Operative Context	Emerging Considerations
B. <i>Social System</i>	
I. Substantive Context . . .	Visible Attention
II. Operative Context	Hardly Visible

It may seem that excessive space has been devoted here to these distinctions, but such is not the case. This developing typology actually represents an abrupt redirection of planning foci and implies some far-reaching changes in the way that planners and their agents should operate. The problem here is that the *process* approach has subtle implications which are very difficult to verbalize. Rosenau [1967] describes the impacts surrounding the initial introduction of this new perspective into contemporary political analysis by Richard C. Snyder in 1954. His article and others by Snyder [1958], Robinson

and Snyder [1965], and Robinson and Majak [1967] describe more fully his "decisional" approach, its linking capabilities in a total scheme of analysis, and the implications for further application.

The point to be made here is that the subtle redirections contained in the *process*, *action*, or *decisional* approach represent a recurring theme for this research effort. Thus, the research may be properly viewed using Figure 4.1, as an attempt to close up the analysis of the open water management system, in terms of substance and process which link technical considerations to the controlling societal overlay.

This, then, places in perspective the analysis contained in Chapters II and III. Ignoring for the moment, the substance and process for the natural system, earlier chapters focused on the social system and its structural or substantive characteristics, thus Block B-I. Parsons' General Theory of Action and Ozbekhan's General Theory of Planning formed the conceptual basis for identifying and categorizing those structural features of (M) and (E) which pose consequences for water planning. However, at the end of Chapters II and III, it was noted that further material would be required to "flesh out" or to give life to these static representations. It was the purpose of Figure 2.12 (p. 61) to bring home this point and to suggest that the trajectory of decision over time with its variety of different decision points was an essential addition to planning considerations. Another dimension was added by Figure 3.4 (p. 82) which described the decision making process as the pivotal element linking knowledge and action in any social system.

All of this suggested that a unifying perspective could be achieved by focusing on the *decision*, in all its various forms, as the

common denominator for integrating the disjointed parts of the water management system. Based on this reasoning the sections to follow review briefly the theories of decision making and identify several critical features of the general water resource decision problem. Then, an organizing framework is prepared to assist the analyst in his effort to match appropriate models to the variety of critical decision requirements. By the end of this chapter the necessary (but not necessarily sufficient) features of the *substantive* and *operative contexts* will have been presented, and the stage will be prepared for two example applications.

The Decision

The decision and its many definitions exhibit a wide variety of characteristics when viewed from technical, economic, management science, psychological, sociological, or political perspectives. However, certain common features can be identified. In this respect, Etzioni [1968, p. 251] has defined *decision* as "a conscious choice between two or more alternatives." Tukey [1960, p. 424] introduces the decision-action continuum with the analogy between decision, and "to act for the present as if" Hence, decisions are those things which precede *actions* [Levin, 1972] and require a commitment of material and/or nonmaterial resources [Linvill, 1972]. Thus, including these essential components, a decision is a *deliberate, human act which, from at least two alternatives, generates a commitment towards a specific course of action.*

Boulding [1966] in his *Ethics of Rational Decision* identifies two further questions created by this generalized problem of decision. The first concerns our knowledge of alternative actions and the consequences they generate. The second focuses on the possible value ordering of the set of alternatives so that "we can choose the right one of them as superior to all the others" [p. B-161]. His central point concerns the value question which impinge on *both* problems, and as such, on the entire problem of decision itself. His remarks capture the essence of decision and its value-laden characteristics as they are intended to be used throughout this report.

Moving from this general description of decision, it next becomes necessary to establish more precisely the various components of any decision situation and to inventory the decision models which correspond to these characteristics. Fortunately, the literature contains a number of exceptional overviews of decision theory, notably Edwards [1954, 1961], Arrow [1958], Simon [1959], Dyckman [1961], Becker and McClintock [1967], Robinson and Majak [1967], Johnson [1968], Bauer and Gergen [1968], among others. However, in order to extract consistent and useful information from such surveys it first becomes necessary to establish a classification scheme designed to organize a wide variety of decision characteristics. The following is a nine-dimensional typology applicable to any decision situation. According to this list any decision or decision situation can be classified on the basis of, at least, nine bipolar dimensions. Other components could easily be added to the list, however, these dimensions are sufficient to provide the requisite organization for the remaining sections.

<u>Component Label</u>	<u>Bipolar Distinction</u>
Nature of Problem	<i>structured</i> vs <i>unstructured</i>
Character of Analysis	<i>normative</i> vs <i>behavioral</i>
Perspective	<i>individual</i> vs <i>aggregate</i>
Decision Maker(s)	<i>unitary</i> vs <i>collective</i>
Nature of Resources	<i>private</i> vs <i>public</i>
Problem Attributes	<i>single</i> vs <i>multiple</i>
Model of Man	<i>rational</i> vs <i>nonrational</i>
Goals	<i>given</i> vs <i>fluid</i>
Influence of Time	<i>static</i> vs <i>sequential</i>

Now, given this list or a subset from it one can inventory and then categorize existing decision models, that is, those approaches, techniques, procedures, methods, etc., used to address a given decision situation. Furthermore, the decision situation itself can be described in this multidimensional fashion. This allows the analyst to match systematically a particular model with a given situation in a way that improves consistency and compatibility. Conversely, the observer has the opportunity to "red flag" those analyses in which the models applied do not meet decision requirements.

Of these two exercises, the latter may prove to be the more important. Since most decision arrangements present exceedingly complex requirements, it is understandable that our models may measure up poorly to each dimension. With knowledge from this typology the analyst can with more confidence display his results along with the appropriate qualifications and explanations. On the other hand, without a systematic method of analysis the unfortunate possibility exists that a mismatch may have occurred leading to a distortion hidden from the analyst.

A section to follow will include further elaboration on several particularly important decision components along with a review of existing models of interest to this research. However, to provide a broader

frame of reference a brief inventory of decision models in general will be included here. As a space-saver, these approaches are outlined in Tables 4.1 and 4.2 using three of the nine components for a rudimentary classification: character of analysis, decision maker(s), and nature of resources. Although it can be argued that increased sophistication and technical advances blur this simple typology, the outlines shown do arrange components and models in a fashion that conforms to the basic decision theory literature.

The observation of interest emerges at this point. The most widely applied and extensively developed category is A.l.a., or *normative approaches considering individual action assuming resources are individually owned or controlled*. If it turns out that the water resource decision problem represents essentially another category, then our traditional focus (although not total reliance) on procedures from A.l.a. may be in part responsible for those symptoms of planning failure identified earlier as the water management syndrome. This in turn suggests that other decision models might be explored for future introduction into the water resource planning system.

Evaluate the Decision Environment

This rudimentary schema now provides a means for assessing each decision problem and then bringing to bear an approach to the problem compatible with its requirements. Implicit in this is the need to investigate the *decision environment* for each class of problems and to identify its requirements possibly using a typology similar to that presented earlier.

TABLE 4.1. TYPOLOGY OF NORMATIVE DECISION MODELS

A. NORMATIVE MODELS--HOW WE SHOULD DECIDE

1. INDIVIDUAL ACTION

a. INDIVIDUALLY OWNED RESOURCES

- (1) *Riskless Decision--complete knowledge*
 - (a) *Rational, economic man*
 - (b) *Theories of consumer, firm, market*
 - i. *classical optimization*
 - ii. *operations research*
- (2) *Risky Decisions--statistical decision theory*
 - (a) *Risk--probabilities known*
 - i. *maximize expected utility*
 - ii. *bayesian statistics, subjective probabilities*
 - iii. *decision analysis--Raiffa, Schlaifer*
 - (b) *Uncertainty--probabilities unknown*
 - i. *minimax, maximin, regret, etc.*
 - ii. *games against nature*

b. COLLECTIVELY OWNED RESOURCES

- (1) *Compensation, Side Payments*
- (2) *Cost-Benefit Analysis*
- (3) *Normative Theories of Pure Democracy*

2. COLLECTIVE ACTION

a. INDIVIDUALLY OWNED RESOURCES

- (1) *Welfare Economics*
- (2) *N-Person Game Theory*
- (3) *Normative Legal Structure*

b. COLLECTIVELY OWNED RESOURCES

- (1) *Normative Political Theories and Policy Processes*
- (2) *Voting Rules*
- (3) *Bargaining Theories*
- (4) *Normative Theories of Organization*
- (5) *Legal Structure*
- (6) *N-Person Game Theory*

B. DESCRIPTIVE MODELS--HOW WE ACTUALLY DO DECIDE

1. INDIVIDUAL ACTION

2. COLLECTIVE ACTION

TABLE 4.2. TYPOLOGY OF DESCRIPTIVE DECISION MODELS

A. NORMATIVE MODELS--HOW WE SHOULD DECIDE

1. INDIVIDUAL ACTION
2. COLLECTIVE ACTION

B. DESCRIPTIVE MODELS--HOW WE ACTUALLY DO DECIDE

1. INDIVIDUAL ACTION

- a. *INDIVIDUALLY OWNED RESOURCES*
 - (1) *Models from Behavioral Psychology*
 - (2) *Models of Multidimensional Behavior*
 - (3) *Studies of Consumer Behavior*
- b. *COLLECTIVELY OWNED RESOURCES*
 - (1) *"Tragedy of the Commons"*
 - (2) *Government Intervention to Correct for Deficiencies*

2. COLLECTIVE ACTION

- a. *INDIVIDUALLY OWNED RESOURCES*
 - (1) *Theories of Social Cohesion*
 - (a) *Exchange behavior*
 - (b) *Shared norms and values*
 - (c) *Conflict and Conflict Resolution*
 - (2) *Theories of Group Behavior*
 - (3) *Operational Games*
- b. *COLLECTIVELY OWNED RESOURCES--public choice*
 - (1) *Political Behavior*
 - (a) *Voting behavior*
 - (b) *Models of policy making process*
 - (c) *Power structure and decision making structure*
 - (2) *Theories of Organization and Administration*
 - (3) *Studies of Bargaining and Coalition Behavior*
 - (4) *Operational Games*

Following such a suggestion, the general water resource decision problem, presented on page 76, will be subjected to the nine-way classification scheme described above. Where possible, the general problem will be categorized precisely, along appropriate dimensions. For components that do not accept precise distinctions, the possible dualism will simply be identified with a presentation of its implications for planning and management. Before proceeding, though, it is necessary to point out that the set of bipolar dimensions do not imply yes-no or either-or dichotomies. Instead, rather than focusing on a single extreme each dualism represents a continuum along which a range of actions are possible. Webber [1965, p. 290] describes precisely the manner in which research and the passage of time can qualify extreme positions into more meaningful positions along each continuum.

Polar distinctions of these sorts are very handy, if one wants to incite others to action or to defend a faith. But dualisms get very blurry under the fine lenses of inquiry. Indeed, the history of modern science records the destruction of one dualism after another.

Components of the General Water Resource Decision Problem

Nature of problem. Simon [1958] provides a precise distinction between well-structured and ill-structured problems in that the latter (1) have essential variables that are nonnumerical, (2) are presented with objectives which are fluid, vague, and nonquantifiable, and (3) lack computational algorithms. More recently, this distinction has forced systems analysts to consider explicitly large, complex or socio-technical systems [Linvill, 1972; Malone, 1972a]. According to

Malone [1972b], in these problems the planning horizon is indefinite, there are few accepted explanatory theories, and behavioral elements are dominant. Considering these features, it seems reasonable to consider the water resource problem to be primarily of the ill-defined type. Hence, we should use with caution those techniques which Simon describes as best suited to well-defined problems.

Character of analysis. Put simply, normative approaches *prescribe* how decisions ought to be made; behavioral approaches *describe* the manner in which decisions are in fact made. From a normative perspective an ideal norm for desirable behavior is followed. Given certain values a priori, a normative procedure would employ pre-specified criteria to select a course of action as the preferred one to satisfy given goals. However, in order to specify in advance operational objectives and criteria, the analyst often must simplify real-world conditions in a way that introduces a certain amount of distortion into the analysis.

The behavioral end of this continuum relates to those approaches which do not presume the a priori existence of specific goals, objectives, or decision criteria. Instead, the emphasis focuses on observing and describing behavior as it actually exists. A behavioral theory seeks to find principles which guide real people's decisions [Rapoport, 1964]. Attempts are also made to simulate or predict the outcomes of human decision activity. Since the decision patterns of people may differ, a behavioral approach will rely in part on classifications, typologies and other means for organizing the investigation of decision situations.

Water resource managers have relied quite heavily on normative decision techniques by using such tools as benefit cost analysis and recently more sophisticated optimization models. These approaches are based on specific value premises and must rely on unfortunate simplifications to be made operational. To balance emphasis along this continuum, planners and other professionals have recently called for the application of behavioral approaches to emphasize real world decision making and human behavior. At this point the bipolar distinction along this component becomes somewhat blurred. It is not sufficient to prescribe, for all to accept, decisions based on limited value positions; conversely, to rely solely on real world decision behavior relative to complex, socio-technical problems would represent a failure to take advantage of techniques which can improve the quality of action. Thus, the appropriate course of action seems to be a blending of the two extremes in a manner that capitalizes on the desirable properties of both approaches. It was in this spirit that Dyckman [1969, p. 299] proposed "to modify the model of normative public action."

Perspective. This component describes the nature of the collective unit under study, or at least the analyst's perspective towards it. At one extreme is the social unit comprised of individual, independent actors such that the facts about society and social phenomena are to be explained solely in terms of facts about individuals [Lukes, 1968]? This represents the doctrine of methodological individualism popularized by early utilitarian philosophers [Urmson, 1968; Parsons, 1968]. At the other extreme, does the social unit have properties and dynamics of its own which cannot be totally explained by individual actions alone? Modern general systems theories suggest this type of perspective.

Certain authors, of relevance to this study, have adopted the individualistic approach by rejecting at the outset any organismic interpretation of collective action [Buchanan and Tullock, 1962; Buchanan, 1966]. Arrow [1968] feels that no harm will be done by using collective approaches "so long as it is understood that such a theory is really a resultant of certain as yet unanalyzed laws of individual behavior" [p. 641].

The issue is an important one whether the analyst specifies his position in the beginning or incorporates unconsciously a certain viewpoint into his actions. Steiner [1970] brings out this fact by contrasting the economic implications of individual vs collective perspectives. For the first case, a concept like the "public interest" has little substantive meaning except that it represents the aggregation of individual utilities. Aggregate benefit-cost analysis, at least the Flood Control Act of 1936 which specifies that benefits to whomsoever they accrue should exceed costs, represents this type of focus. However, aside from the fact that utilities cannot be summed across individuals, this individualistic emphasis ignores the state-of-the-system, that is, those collective features which transcend individual phenomena.

Steiner also relates a group or collective viewpoint to its implications for economic analysis. In this case interdependencies and interactions among people permit society, as well, to be viewed as an independent entity with its own value ordering. This condition, in contrast to the atomistic case, invites a search for social priorities and gives substantive meaning to societal states, the "public interest," and questions of equity and distribution.

As was mentioned in the Preface, the perspective adopted in this study tends to split the difference and follows the recommendations of Etzioni [1968] and Steiner [1970, p. 39]. In his *language of societal action* Etzioni acknowledges the importance of individual actors but assumes that they are bound into social units "in such a way that no unit can move significantly without the movement of others" [p. 70]. His in-between position emphasizes the stickiness of social action but does not submerge the consequences that flow from individuals as well.

To repeat, whether conscious or unconscious, a planning criterion such as "benefits to whomsoever they accrue" reflects a particular planning perspective; in this example the state-of-the-system is simply identified by summing the states of individuals. But, adopting this specific perspective does not lend easily to an analysis of other conceptions of the state-of-the system. Argyris [1973, p. 256] has described a similar problem among organization theorists who investigate only those factors made visible by popular theories, "what was considered relevant to the analysis was what their theory of problem solving dictated."

Thus, by expanding the atomistic perspective and adopting one which recognizes organismic phenomena, routine study of system features becomes possible. Explicit premises like the language of societal action provide the requisite justification of and encouragement for subsequent analyses into questions of equity and fairness, interest group interactions, collective decision behavior, coalition formation and so on. Without such premises the following investigations would be

justified only on the basis of intuition or on the fact that other researchers were beginning to study similar aspects of the problem.

Decision maker(s). Overlap exists between this and other components especially the previous one concerning the individual vs aggregate perspective. However, a distinction can be drawn between the more abstract nature of the foregoing dimension and this situation-specific component. In brief, the issue here focuses on each decision situation and whether it requires a *unitary* or *collective decision*. In each case, the appropriate models may be different. If the following condition is met, the problem in question can be addressed using a unitary decision mechanism: the probability should be zero that a decision maker is compelled to accept a result contrary to his expressed preference. Leoni [1957], Coleman [1966a, 1966b, 1966c], Rogers [1970, 1971], and Buchanan [1972] elaborate on this condition and agree that a *collective decision is one where individuals in the social unit agree to adopt a specific course of action, by some mechanism, and all must conform to the consequences of the joint decision once made*. The requirement for collective action may arise from several sources:

- (1) No single person has control over all the action;
- (2) An individual may not have control over the necessary resources to implement fully his personal preference;
- (3) Another person's action may have consequences which alter the preferred outcome of the decision maker in question;
- (4) If the possibility exists that two or more persons acting together may do better than each acting alone; thus
- (5) The probability may not equal one that an individual's preferred choice conforms to the choice of the collectivity to which he belongs.

Nature of resources. Again, this decision component overlaps features of the preceding dimension, yet it is not completely subsumed by the requirements for unitary vs collective decisions. The question of private vs public goods (resources) has been extensively covered in the economics literature, notably by Paul A. Samuelson. Other sources provide readable analyses of the complexities surrounding this issue [Head, 1962; Davidson, 1967; Davis and Whinston, 1967; Hardin, 1968; Steiner, 1970; Frolich *et al.*, 1971]. In brief, purely private goods are fully separable and are subject to exclusion in possession, exchange, and consumption [Ostrom, 1972a]. Ostrom continues by describing the events or goods which depart significantly from purely private status:

- (1) *Externality*, an uncontained effect of an individual's activity which interferes with the activity of another;
- (2) *Common Pool/Flow Resource*, one which is not divisible and is shared in common but which may be used separately by individuals; and
- (3) *Public Good*, one which is not divisible and is shared in common but no one can be excluded from the benefits which the good makes available to others.

The components *decision maker(s)* and *nature of resources* are related closely enough that their character with regard to the general water resource decision problem can be discussed simultaneously. Many water related examples can be cited for which a unitary decision over purely private goods would be appropriate. However, the dominant features of the water resource management problem are that of public resources [Ayres and Kneese, 1969; Kneese *et al.*, 1968, 1969; Ostrom, 1968, 1972a; Ostrom and Ostrom, 1970, 1972; R. Davis *et al.*, 1972] and the requirement for collective action [Haefele, 1970b, 1971a, 1972;

Ingram, 1970, 1971a, 1972; Ogden, 1970; Wengert, 1971]. At least, these features became the central concern of this research.

Problem attributes. All decision problems in water management are characterized by multiple attributes or properties. In these situations it is rare that a single course of action is preferred along all attributes. Most often, some alternatives are preferred when certain particular attributes are considered while other alternatives become preferable when different attributes are examined. How then are and should such choices be made?

The explicit consideration of multiple attributes, for example, decision properties, decision criteria, objectives, etc., has only recently become established as an important component of resource planning. In fact, the *first* seminal study of this problem entitled *Multiple Criteria Decision Making*, containing some 800 pages and 60 contributors, has just been published [Cochrane and Zeleny, 1973]. In addition, Fishburn [1967], MacCrimmon [1968], and Johnson [1968], provide general surveys of various analytical approaches to the problem. Shepard [1964], Johnson [1968], and Klahr [1969] begin to explore human behavior reflecting the existence of multidimensional situations. Extensive work has been done by MacCrimmon [1969], Miller [1969], Pardee *et al.* [1969], and Raiffa [1969] in the area of transportation planning. This approach can be described as an attempt to aggregate the separate problem dimensions into a single index of effectiveness.

Notable efforts have also been directed to the complex multiple-use characteristic of natural resource planning. Among these, McHarg's *Design with Nature* [1969] and a more practical example of his

[McHarg and Clark, 1973] represent the most influential work. Steinitz *et al.* [1969] review sixteen comparable resource analysis methods. Performing a similar task, Litchfield [1970] reviews various methods proposed for the multidimensional problem in the context of urban and regional planning.

Except for McHarg's practical application and excluding recent attempts to evaluate diverse environmental impacts, the multiattribute feature of water resource problems has received very limited attention. Thuesen [1971] applied Miller's [1969] approach from transportation planning to various objectives in water planning. Brown *et al.* [1972] used multidimensional scaling techniques to establish an index of water quality. Recent emphasis on multiple goals stimulated by the Water Resources Council has resulted in a summary of nineteen tests on water resources projects [U.S. Water Resources Council, 1970]. However, given the other efforts in natural resource and public works planning, these examples do not suggest a similar level of development for water problems. Nonetheless, a full multiattribute perspective has been adopted for this study.

Model of man. Every planning act carries with it an explicit or implicit model of man's underlying rationality. In this context, rationality is not intended to mean the range of behavior from irrational (mentally deranged) to rational (acting with reason). Nor does it refer to a common but less general definition, the degree to which individuals conform to prespecified rules of behavior. Instead, rationality is used here to identify specifically the extent to which men are expected to follow the decision theoretic postulates of rationality,

including the models of planning, organization, administration, political, and social behavior which flow as a direct consequence from this rational prescription. This model has received much discussion in the literature, for example, Edwards [1954], Schoeffler [1954], Simon [1957a], Lindblom [1959], Pfiffner [1960], Riker [1962], Buchanan and Tullock [1962], Stuart [1969], and many others. It specifies that man is a pleasure-seeking, self-interested, maximizer along with a number of more specific characteristics which can be translated into mathematical terms.

The details of this prescription for behavior are familiar enough that they need not be repeated here. However, it is important to note that a number of critical consequences flow from this model whether it serves as the basis for planning behavior or as a model of the recipients of planning output. Most important among these consequences is the fact "that it influences what is observed and what is considered important" [Argyris, 1973, p. 260]. Ramos [1972] adds to this analysis of the implications that flow from the rational model:

- (1) A bias toward authoritarian methods of resource allocation;
- (2) A tendency to adjust the *recipients* to the imperatives of production maximization, not the reverse;
- (3) A view that man is motivated by (and thus satisfied) by material and economic rewards; and
- (4) An indifference to value questions in the external environment.

Such consequences alone would be sufficient justification to preclude adoption of the rational model in this study. But, along with the extensive "rational" literature is an equally vast one describing the ways in which real-world actions must diverge from

strict rational prescriptions. Examples include Katona [1953], Edwards [1954, 1961, 1967], Simon [1955, 1957b], Lindblom [1959], Friedmann [1967], Dror [1968], Morris [1972b], and others. Hence, strict rationality as a *prescriptive* or *descriptive* mechanism was not adopted as a central building principle in this study. This does not mean that analyses to follow are unorganized, irrational, or without reason. Instead, the approach when compared to rationality should be viewed as nonrational, that is, something different. At this point, the bipolar distinction becomes somewhat blurred in that, if this different approach becomes a prescription for action, it in turn becomes the "new" rationality. But, all that has been said is that traditional rationality will not be a requirement. A more detailed description of the emerging model of man was presented in Chapter II.

Goals. On page 27 it was assumed that man has the capacity to exhibit goal-seeking behavior, which is a somewhat diluted version of Abraham Maslow's [1943, p. 395] conclusion that "man is a perpetually wanting animal." Thus, the assumption, in this study, that man displays purposeful goal-oriented intervention into his environment is the "vital force that determines not only the action proposals but the entire cause of inquiry and study" [Young, 1966, p. 79].

Although we readily accept given goals as a guide for planning behavior, the validity of this action is not clearly established. Buckley [1968] in his *Modern Systems Research for the Behavioral Scientist* covers in detail the debate which has raged over teleology and purposeful behavior in a "general systems" context. Even though the thrust of these systems discussions favors the adoption of a goal-

seeking perspective, Morris [1972b] describes the human unwillingness (or inability) to be specific about goals or to use goals as a guide to decision behavior. Instead, according to Morris, we tend to resist being explicit about objectives and tend to modify our goals to match the revealed outcome of choice behavior.

Nevertheless, the concept of goals has been established as an important component of planning action [Davidoff and Reiner, 1962; Altshuler, 1965; Young, 1966; Ozbekhan, 1968b]. Goal concepts have also led to the current emphasis on social indicators for measuring society's position relative to accepted social goals [Bauer, 1966; Terleckyj, 1970]. In this spirit, The Technical Committee [1971] employed a hierarchy of social goals and indicators in a methodology for water resource planning. Bromley *et al.* [1971] investigated the means-end continuum and its relation to water related decision making. Thus, it seems appropriate to retain a goals concept as an essential component of the water resource planning system. However, the strict means-end perspective [Banfield, 1959] has been abandoned in this research, for a more fluid ends-ends approach. In this sense, the dominant interaction takes place as a tradeoff among different values and goals not between means intended to satisfy "given" goals. Thus, as Young [1966] has pointed out, discussions of goals will fall into two classes:

- (1) *Structural*--identify, examine, promote specific goals; and
- (2) *Process*--conceptualize the role of goals in the process of decision making.

Influence of time. The trajectory of activities shown in Figure 2.12 [p. 75] introduced the concept that planning and decision making have meaning over time. This feature can emerge in at least two ways. First, is the problem a one-shot enterprise? Large water resource projects, for example, represent essentially a one-time commitment of resources over a substantial time horizon. On the other hand, is the problem one which will be reviewed, modified, or revised within the short run? This first meaning of time, therefore, refers to the sequencing of outputs not to the process by which outputs are determined.

The second way that time enters is through the fact that the decision making process itself evolves over a series of phases. Mackenzie [1968, p. 368] has described the changing "climate of opinion" in a collectivity within which the interactions between members are so complex that they resemble fluid motion. Levin [1972] is one of the few investigators to study specifically these separate processes that intertwine over time (see Figure 2.12). He identified technical, administrative, and political strands within various public works projects and proposed a two-way classification scheme (% commitment vs % specificity) as a guide to decision analysis. Levin's analysis represents one of the few efforts, to date, to separate the different braided processes and to study their interrelationships in a (quasi-) technical way. Others studying group and community processes have likewise identified the various time phases of decision making, the different actors associated with each phase, and the characteristics of the processes within each phase, for example, Nuttall *et al.*

[1968], Rogers [1971]. Linvill [1972], a systems analyst, attempts to blend technical and other activities into a "cascade of brokerage operations," which can then be subjected to more comprehensive analysis.

Water resource problems often have one-shot characteristics; they also have historicity and take on meaning over time. This can be seen in Fisher's [1971] article which traces the 150 year evolution of the Cross Florida Barge Canal project. More immediate, though, are the needs to reflect into planning methods the shorter duration decision trajectory. In this spirit, two separate studies have attempted to simulate the water management process over time [Knight and Hines, 1970; Males *et al.*, 1970, 1971; Gates *et al.*, 1970]. By using industrial dynamics [Forrester, 1961], they were able to simulate the continuing decision process surrounding water quality problems and to predict outcomes resulting from different management policies. In a more technical vein, Warfield and Hill [1972] describe various systematic techniques for addressing the time component of socio-technical problem solving, for example, DELTA charts, interaction matrices, spiral diagrams, etc. These approaches not only reveal the need for blending the technical question with overall decision processes, but also increase the likelihood that further study will improve our ability to deal with this difficulty.

Meeting the Requirements

In the previous section, the general water resources decision problem was subjected to analysis using a nine-way classification scheme that applies to any type of decision problem. This systematic examination revealed the requirements of the water resource decision situation and provided a device for identifying those features which defined the thrust of this research. For this purpose, then, the general decision problem was presumed to:

- (1) Be an unstructured socio-technical problem;
- (2) Require a blending of normative and behavioral approaches, at least until more meaningful prescriptions for behavior have been developed;
- (3) Be represented best by the "language of societal action" which not only accepts the importance of independent, individual action but also adds an ingredient of system-wide integrity emphasizing the importance of human interaction;
- (4) Require a collective decision mechanism in which a single actor cannot predict with certainty whether he will be on the winning or losing side based solely on his preferences;
- (5) Be dominated by the collective or public resource question;
- (6) Be multidimensional with respect to properties, criteria, and objectives;
- (7) Involve nonrational men and not require that the logical, deductive model of rationality be the dominant guide to desirable behavior;
- (8) Be represented by multiple, fluid goals which ebb and flow during planning activities; and to
- (9) Have consequences over time for related activities.

Hence, we have a problem portrayed as *ill-defined, requiring collective action among unpredictable men, focusing on uncertain and conflicting goals*. Although other analysts might propose contrasting

interpretations for certain dimensions, there would appear to be general agreement on this overall characterization of the general water resource problem. One difference does exist, though, between traditional efforts to address this problem and the approach suggested in this study. It is very rare to find an effort which maintains the problem at this full dimensionality. Several reasons readily encourage this reductionist strategy:

- (1) Temptation to search for analytic solutions and "right" answers;
- (2) Conscious desire to study a single dimension by itself;
- (3) Legitimate inability to handle the full-dimensional case; or
- (4) Lack of awareness of full dimensionality.

In contrast, this research accepts without modification the fully dimensioned problem as the appropriate one to address. Although later sections will converge on one phase of the generalized decision situation, the analysis still maintains intact other overarching features of the total problem. No simplifying assumptions are made to insure solvability. Moreover, any results must be viewed in the glare of the full-dimensional case.

The Collective Action Approach

A consistent theme in these requirements is the need to explicitly consider collective action. The general decision problem boils down to a resolution of diverse value systems or the aggregation of individual preferences into a single expression of collective choice. Hardin [1968] feels that this problem has a solution if certain simple assumptions are met. Crowe [1969], on the other hand, rejects Hardin's

assumptions under contemporary social conditions and describes the problem as technically and politically insoluble. In either case, the central issue remains the integration of diverse value systems.

Whether or not there exists an identifiable unanimously accepted solution, certain alternative courses of action do in fact come into being. Then, once implemented, any course of action carries with it a distribution of advantages and disadvantages for the individuals and groups affected. Thus, under any circumstances, except possibly complete harmony, questions of winners and losers become prominent. Such questions are addressed primarily by collective action of some type. However, "If individual actors in the economic process are assumed to be divorced from the decision-making structure that defines the constraints of their behavior, the openness of the system must be acknowledged" [Buchanan, 1972, p. 14].

This can be placed in clearer perspective by reflecting on the General Theory of Action (Figure 2.2, p. 45). Parsons fully recognized the problem of internal conflict which flows from the satisfaction of collective goals. Any single collective expression generates an array of positive and negative effects within the social unit. It then becomes one of the functional subproblems of any social system to integrate its members for continued system maintenance.

The collective action approach focuses on Parsons' integrative subsystem as a means of introducing into the planning process the competition that exists for advantages and disadvantages. Questions of equity and fairness follow immediately and are defined differently by each mode of collective action employed. Thus by exploring the various

avenues of collective action one can begin to address the problem of who gets what and under what circumstances. This also provides an entry into the planning process for group interactions, which are fundamentally an integrative mechanism and which figure prominently in water related decisions.

The sections to follow, then, can be viewed as an attempt to focus on various mechanisms of collective action and the ways in which they might be reflected in the planning process. Traditional approaches, on the other hand, were usually aggregate analyses in that desirable plans reflected a sum of positive effects in excess of the sum of negative effects. The underlying distribution of effects and the collective interactions surrounding various alternatives were easily subsumed by this omniscient, centralized perspective. Thus, it might be said that, under the weight of experience with traditional approaches, the aggregate analysis has received more than its share of planning attention. Explorations in the remaining sections attempt to balance the emphasis more reasonably between the aggregate and the disaggregate or integrative problem.

A Conceptualized Arena

Anything more than rudimentary notions of collective action have only limited access to contemporary planning models and activities. Here and elsewhere in this report, "model" refers to more than just an analytical or mathematical device used for one purpose or another. Instead, "model" describes, as well, the fundamental principles that shape planning behavior or, if not explicitly stated, that are reflected

by planning actions. Thus, a model is the basic component of the planner's cognition and shapes his perception and approach to given problems. Furthermore, it has been well established in the literature on planning and organizational behavior that the dominant, persistent mode of planning actions follows the logical deductive model of rational behavior. For example, Dyckman [1971, p. 327] states that, "the rational ideology--continues to be the dominant mode of both official and folk analysis. . . . The concepts of urban studies are strongly infused with classic conceptions of rational behavior in spite of cumulative evidence of . . . determinedly nonrational behavior. . . ." Thus, since collective action is poorly represented in contemporary planning models, the following attempt to introduce these concepts may well appear as a disruption in the cleanly flowing expectations of rational action.

Again, notions of collective action have only limited access to contemporary planning processes. Of course, it would be naive to suggest that planners are oblivious to group interactions that have consequences for planning activities. However, this penetration of the planning sphere by local integrative processes cannot be attributed to a systematic, organized collective action approach. More likely, any influences reflected in planning outcomes result from a "brute force" convergence of groups, each with interests to protect.

This suggests a need for a mechanism or device, a something, that will make collective action visible and easily introduced. Integrative concepts cannot come to life in a planning framework that does not provide for their existence. Argyris [1973] explains clearly how a given theory of problem solving dictates what is considered

relevant to an analysis. For example, if it were proposed, to a planning agency, that the Siegel-Fouraker bargaining model be included in the planning process, an expected reaction might be, "How is this useful?" Such a response may not mean that interpersonal, group, and intergroup factors have no consequences for planning outcomes. Instead, planning models tell us what *should* be observed and what *should* be considered important [Argyris, 1973]; they act as filtering mechanisms submerging certain features and accenting others as deserving of our attention. In terms of the contemporary rational model, the major steps (problem definition, goal setting, investigation of alternatives, decision, implementation) preclude an introduction of win-lose competition, coalition formation, and other behavioral phenomena which should infuse the overall process. There is no vehicle which translates or gives operational validity to collective action concepts. There does not exist an organizing framework which gives meaning or a sense of usefulness to investigations of the integrative problem, at least with respect to planning behavior. To this end, Linsley and Willeke stated that, "The planner is expected to provide structures by means of which this can take place" [Wilson, 1973, p. ix]. Moreover, Ingram [1971a] believes that patterns of political action in water resource development have already started to adjust themselves to accommodate this need.

To recap, it has been argued that more emphasis should be focused on the disaggregate analysis of water problems; this corresponds to Parsons' *integrative subsystem* [Schevitz, 1968]. It was further argued that contemporary planning procedures have no structure

which gives visibility to or provides access for integrative phenomena. To satisfy this requirement, it is proposed that a *conceptualized arena*, a locus for collective action, be introduced as a specific component of planning procedures. A barrage of questions follow immediately on the heels of this recommendation; some can and others cannot be addressed at this time:

- (1) What is the arena's structure?
 - (a) Who occupies it;
 - (b) Where is it located in the decision situation; and
 - (c) What is its relationship to planning activities.
- (2) What processes take place in the arena?
 - (a) What types of interactions are permitted;
 - (b) What decision rules are applied; and
 - (c) How are influences from it used.
- (3) What are its purpose, scope and capability?

To answer all of these questions here would amount to a treatise on normative and descriptive political theory, its decision structures, rules, and processes. However, since this research represents an initial exploration of such a proposed concept, a more indirect approach to these questions would seem permissible. Thus, it is hoped that a reasonably clear portrait of the arena will emerge through a survey of its guiding criteria and possible applications.

For the moment, let us assume that the arena is issue-specific, that is, water related. Furthermore, the arena is occupied by actors who are affected by or involved in the water question: elected officials, planners, administrators, representatives from organized interest groups and less organized "latent" groups [Olson, 1965], and so on. Given this, what does the arena look like?

- (1) First, it might only be a part of the planners' cognition. During his deliberations over the pros and cons of each alternative, the planner would also superimpose his estimation of the political interactions facing plan acceptance. Mental activities like this along with within-agency brainstorming relative to the political climate represent the application of a subliminal arena, but an arena nevertheless.
- (2) At a higher level of formality, the conceptual arena might be superimposed over the process of plan formulation using special consultants, computerized aids, etc. In contrast to the first case, here the arena received deliberate attention. Consultants could identify important groups, leverage points [Gergen, 1968], and possible "add-on" concessions which might neutralize any opposition [Ingram, 1971a; Mumphrey *et al.*, 1971]. Computerized political simulations or models which speed up incremental analyses [Bishop, 1970] could intensify this considered, purposeful analysis of the appropriate arena.
- (3) The first two models represent uses of the conceptual arena which do not include direct interaction with groups or publics affected. Thus, the next level of arena development might include hearings, workshops [Borton *et al.*, 1970], public participation programs [Warner, 1971], and other activities intended to extend communication networks to the appropriate actors.
- (4) Extending this concept of direct communication, a higher level of personal contact might be achieved through interactive processes within the decision making arrangements. Unlike the previous case where outside representatives were passive ingredients in agency programs, here the dominant theme would be active involvement in planning and decision activities:
 - (a) At a low level of interaction there might be positions for professional advocates [Ross and Guskin, 1971; Davidoff, 1965; Freeman, 1969], ombudsmen [Sandler, 1968; Nelson and Price, 1968], and other representatives from outside interests.
 - (b) Increasing the intensity, these representatives might engage in actual interactive sessions. In this case, various decision rules might be employed as a means of investigating questions of equity, among other things. Operational games [Raser, 1969; Environmetrics, Inc., 1971], computer assisted bargaining techniques [Kahan and Helwig, 1971; Flack, 1972; Flack and Summers, 1971], and other behavioral science techniques for assisting interaction [Dalkey, 1969; Rescher, 1969; Heinwill, 1971] might be used to stimulate collective actions.

- (5) Finally, the interactive approach might be extended to the point that the issue-specific arena had final decision responsibility for water resource programs. In this case, more specific attention would be focused on the means of choosing representatives, the precise decision rule to be followed, the higher authority (non issue-specific), etc. Here, research into the design of organization and decision structures [Ostrom, 1971a, 1971b, 1973; Fox, 1971c; Ranney, 1972] would enter the analysis in a very important way.

This range of possible conceptual arena Modes now provides an opportunity to be more specific about the intent of sections to follow. All along, this report has taken the form of ever-narrowing circles pointing to a specific point of application. At first, the overall system was formalized in terms of *structure* and *process*, the general theory of action and the decisional approach. Within this framework, the *integrative subsystem* was selected for further analysis since questions of equity, fairness, group interaction, distribution of effects, etc., relate primarily to this component. Now, within this subsystem a range of possible collective action Modes have been identified relative to a conceptualized arena, a device within the planning process.

The current needs of water resource planning suggest very strongly that case number four (4) should become the focus for analysis. This also means that certain characteristics from cases (1), (2), and (3) must naturally be included since the range of options were not independent but expanded gradually through the list. Number four emerged for various reasons:

- (1) The pressure for participation and involvement;
- (2) The need for analytical treatment of collective action;

- (3) Rising questions of equity, fairness, disaggregation, etc.;
and
- (4) Inability to move to level (5), at least for now.

Here, one qualification must be made, namely, in the real-world absence of established interaction programs the methodology must be carried through as if these activities should and could exist. Data sources should be presumed to exist, and moreover presumed to provide essentially the same data as might be expected from continual, professionally-staffed participation programs. The primary implication of this assumption is that the agency, or whoever is nominally in charge of the arena, *will act in good faith*. Hence, their primary objective will be to explore questions posed by the integrative problem and to relate their findings honestly to planning and design.

Figure 4.2 contains a schematic diagram of the Mode described by case (4). It shows the technical planning process and the social decision trajectory (extracted in the participation program) traveling in parallel paths but linked periodically by the conceptual arena. Time between iterations would be a function of meeting schedules, computer turn-around times, and so on. Overall, from beginning to end, the trajectory would include those phases held in common by most community or social decision processes. Rogers [1970] provides a useful and concise description:

- (1) Phase I--*stimulation* of interest in the need or new idea;
- (2) Phase II--*initiation* of the new idea in community awareness;
- (3) Phase III--*legitimation* of idea by those who represent community norms or possess social power;

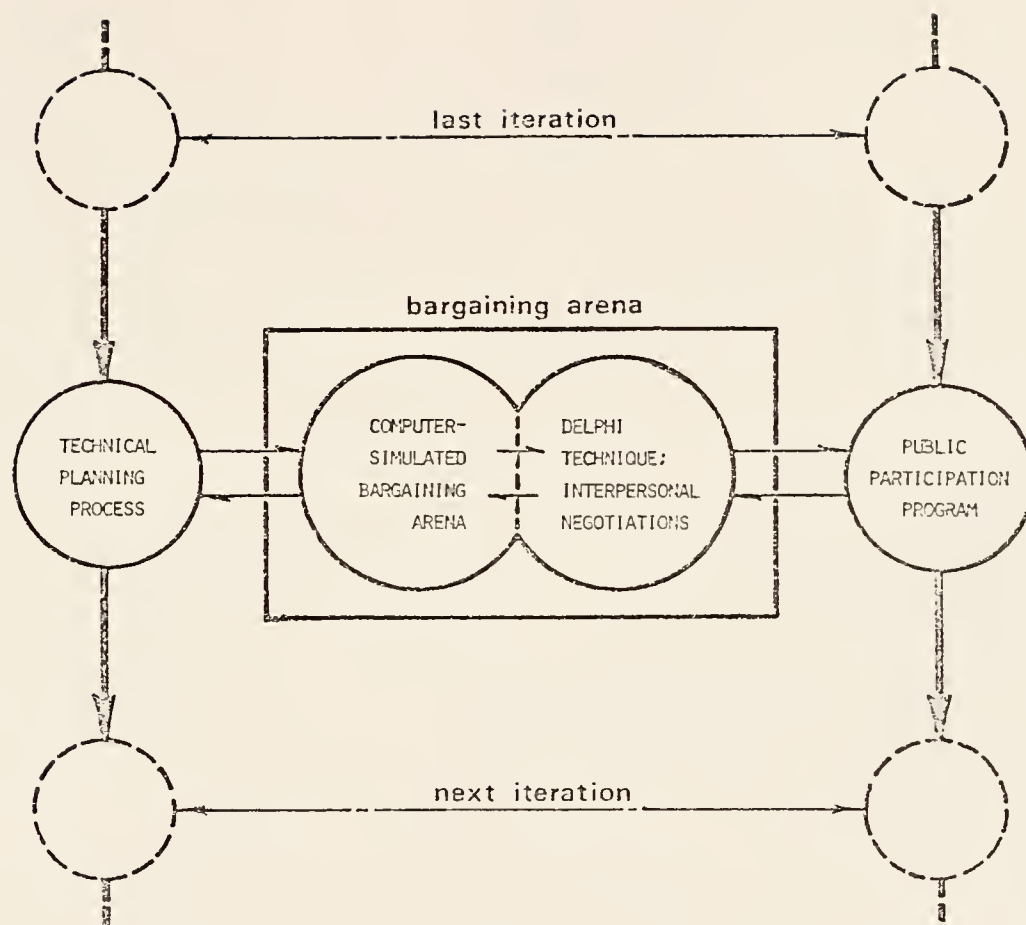


Figure 4.2. Trajectory of the Conjoint Planning Process

- (4) Phase IV--*decision* to act by members of social unit; and
- (5) Phase V--*action* or implementation of new idea.

There is no reason to expect that the arena would be dormant in any of these phases; however, the nature of its interactions might well shift from phase to phase as requirements change. Also, there is no real need here to narrow any further the focus of this research. But, with reference to specific examples to follow, a portion of Phase III, all of Phase IV, and a part of Phase V might contain the most direct applications. This corresponds to preliminary screening, evaluation, recommendation, and implementation of plans.

From Figure 4.2, then, it is possible to visualize an arena positioned between technical activities and on going social decision processes. However, it is less clear how they might be connected operationally. Assuming that information flows serve as the primary linking mechanism, the problem becomes one of translating information extracted from the collective action process into a form which is meaningful for more technical functions. Collective action models surveyed in a later section begin to provide this service.

How might the conceptual arena be used? First, since Mode (5) was not adopted, the arena does *not* have final decision power. This conforms more to existing planning arrangements and thus leaves the final recommendation and decision to established channels. Also, it means that at this time specific rigid statements do not have to be made concerning:

- (1) Members and how they are to be selected;
- (2) Types of interactions to be permitted;
- (3) Specific decision rules which must be followed; etc.

This hesitancy about recommending Mode (5) does not dodge the issue, although it may appear this way at first glance. In fact, the opposite is true. Any codified set of operating procedures, i.e., Mode (5), will let only certain types of solutions through. Any specific set of decision rules will generate its own characteristic subset of allowable plans. Thus, by specifying ground rules for Mode (5) in advance, not only would we define a limited range of potential recommendations, but also we would bias the distribution of positive and negative effects to those associated with each set of decision rules. Therefore, instead of representing a solution to the general water resource problem (at least under contemporary organizational and decision arrangements), a specification of Mode (5) would only preclude the broadest investigation of group interaction, equity, and other questions associated with the integrative problem. Mode (4), then, provides the planner with an unconstrained device which permits and even encourages the exploration of collective action and all of its diversity.

Again, how might the arena be used? At least two possibilities present themselves: one with the existence of established participation programs, the other without. Referring to Figure 4.2, if involvement-type programs exist, a wider variety of human-computer interactions exist. Furthermore, real actors in the water question are available to provide data on attitudes, perceptions, preferences, goals, aspiration

levels, and so on, through delphi techniques, group gaming sessions, and numerous behavioral science methods. With this data, analytic solutions could be generated under a variety of decision arrangements to be reviewed and revised through successive arena iterations.

For the second case, if participation programs do not exist, the analysis would *proceed in the same spirit*. Here, though, due to the absence of human participants more reliance would be placed on computerized or analytic simulation of arena behavior. Appropriate data would be obtained from the best available sources.

In either case, what might be some benefits of the conceptual arena to the planning and decision process?

- (1) Introduction of a mechanism to encourage active, purposeful intervention into water-related affairs [*The Active Society*, Etzioni, 1968];
- (2) Initial attempt to establish a "linkage between scientific-technical intelligence and organized societal action" [Friedmann, 1971, p. 318];
- (3) Provision of a framework for aggregating individual preferences into a social choice, thus a framework for resolving diverse value systems;
- (4) Give more meaning to a planning agency's search for "consensus," "The public interest," "social goals," etc.;
- (5) Encourage planning and decision responsiveness to changing needs. The "degree of responsiveness to the changing needs of all its members significantly affects . . . [a planning system's] capacity to realize most societal values" [Etzioni, 1968, p. 503];
- (6) Wider access to the planning process for incipient groups previously denied access; thus counteracting an American tendency toward "stable unrepresentation" [Gamson, 1968];
- (7) Provide a broader forum for shared knowledge;
- (8) Serve as a focus for public participation, advocacy, ombudsman, and other programs for the redress of grievances;

- (9) Definition of a controlled environment for research into interaction procedures, organizational arrangements, decisional processes, and other related matters;
- (10) Serve as a sounding board for various proposals and accelerate "feedback" of information about changes in both internal and environmental states [Friedmann, 1971; Thompson *et al.*, 1971];
- (11) Permit broader evaluation and justification of recommended programs;
- (12) Permit a search for and matching of decision rules and arrangements to requirements of problem;
- (13) Reveal not only preferences but the intensity of preference through a willingness-to-act on the part of each actor involved. (Preference *intensities* are a necessary ingredient in social choice deliberations [Rae and Taylor, 1969, 1970; Kendall and Carey, 1968]);
- (14) Force a cooperative game where through coordinated efforts a higher joint outcome might be achieved. This contrasts with zero-sum games where there are distinct winners and losers;
- (15) Since "effects" and "impacts" are properly assessed in a social context [Gilbert White, 1966], the arena establishes a setting for these investigations;
- (16) Problems of implementation would become exposed at an early stage;
- (17) Provides a forum within which to encourage "structured" conflict;
- (18) Provides an opportunity to "change the game" thereby exploiting the integrative potential of the arena situation [Walton and McKersie, 1966].

Criteria for Assessing Arena Performance

The previous section described Mode (4), a proposed relationship between a planning agency and affected publics who assume an active (not passive) role in ongoing planning activities. Moreover, Mode (4) was not intended to represent new and final decision arrangements; instead, the conceptual arena was visualized as a mechanism which planners, operating under existing decision constraints, could use to infuse their activities with integrative phenomena. In the absence of

the recommendation of mode (5), certain problems, which now face those who study decision arrangements, were avoided. However, this does not preclude an investigation of specific criteria which should be used to judge the arena's performance no matter which mode, (1) through (5), were selected. The analysis to follow next relied heavily on Robert A. Dahl's *After the Revolution* [1970], a very readable work with a misleading title, and a similar investigation for water management by Irving K. Fox, *Water Resources Policy in Wisconsin: A Summary Assessment* [1971c].

According to Dahl, the three main criteria for judging whether I should accept as valid and rightful, and therefore binding on me, a *process* for making decisions on matters that affect me are the Criterion of Personal Choice, Criterion of Competence, and Criterion of Economy.

Criterion of Personal Choice. Using this criterion to assess arena performance would focus on the degree to which the arena produced decisions which correspond to my own personal choice. Naturally, I want the correspondence to be 100 percent. But, to be valid in a collective decision context this same rule must apply to all others, and so, *all* should likewise regard this criterion as legitimate. Diverse preferences, though, lead to disagreement, conflict, and a breakdown of this criterion, except for the majority (if majority rule applies). For this specific difficulty, Dahl identifies several solutions that can be used to adjust for the failure of Personal Choice to serve the minority:

- (1) *Mutual Guarantees* by which majorities are restrained from imposing themselves over questions regarding the most deeply cherished values of the minority;

- (2) *Consensual Associations* by which losing minorities split into homogeneous groups that can satisfy exactly personal preferences in their separate associations;
- (3) *Consumer's Choice* by which the need for collective decision is eliminated. Each individual choice corresponds to each individual preference; and
- (4) *Arbitration-Adjudication* by which coordinated and cooperative effort is encouraged.

Criterion of Competence. The previous case required that each member be nearly equal in their competence as decision makers. But here, Dahl explains that I may accept as binding a decision made by a person who is particularly qualified by his knowledge or skill to render correct judgement. Therefore, it is rational in some cases that *everyone* should *not* have the right to participate in decisions; air-planes and operating rooms are trivial everyday examples. But, where should participation stop and the appeal to competence begin? This has no easy answer; however, Dahl comments on those instances in which some consider ordinary people generally incompetent to handle certain complex problems. "On the whole the ordinary man is more competent than anyone else to decide when and how much he shall intervene on decisions he feels are important to him" [p. 35]. In other words, ordinary men may not hold all the technical expertise, but they can tell when things are going wrong.

Criterion of Economy. The two previous criteria suggest the traditional bipolar distinction between popular rule and rule of elites. In that debate, a third criterion is usually forgotten. Because of an unwillingness to spend time, deadlines, time limitations, and the fact that certain events will not wait, the economy criterion often assumes

a dominant position when decision arrangements are being evaluated. Dahl has no specific answer for the question "how much time," except that opportunities foregone by time overruns might serve as a deciding measure.

From this fundamental discussion it becomes clear that the assessment of arena performance is a multidimensional task. Under any given set of circumstances, the arena would be graded according to (1) how well individual preferences corresponded to the final solution, (2) how well legitimate expertise was meaningfully used, and (3) how well the total process conformed to the requirements of time. Furthermore, each set of arena characteristics, that is a given arena design, would be more desirable along certain dimensions and less desirable along other components when compared to an alternative arena design. Hence, no single set of decision arrangements dominates any other. Dahl [1970, p. 58] remarks, ". . . it would be folly to think that a single . . . model . . . can possibly fit all the kinds of associations we need in order to cope with our extraordinarily complex world." In this same spirit, Fox [1971, p. 23] adds, ". . . in any situation where value preferences differ substantially no single organization is capable of taking into account and weighing objectively the full range of value preferences that exist." Therefore, no single way of designing the arena can be "optimal" for all problems in water resource management, and considering the Criterion of Economy a supposedly "optimal" arrangement will probably deviate substantially from an "ideal" design [Dahl, 1970, p. 48].

Dahl's analysis gives the most fundamental criteria for assessing arena performance, and as such is consistent with the level of generality maintained throughout this writeup. However, this section would not be balanced without introducing the recommendations of Irving K. Fox who for at least a decade has been closely identified with institutional and organizational aspects of water resource management [Fox, 1965, 1966, 1969, 1971a, 1971b, 1971c, 1973].

As an introduction, it's interesting for this research to note his comments relative to the arena concept and applicable decision rules. For example, "The only answer to this problem [value resolution] . . . is to foster the establishment of multiple organizations . . . which are in fact capable of reflecting the range of views that members of society hold and to provide *arenas* [emphasis added] in which these organizations can negotiate and bargain with one another" [1971c, p. 23].

To anchor his recommendation of desirable criteria, Fox begins with the contention, based on work by Harold Lasswell and Karl Deutsch, that what constitutes an appropriate or desirable set of decision arrangements is determined by the set of values that govern inter-individual relationships in a society [1971c, p. 6]. He then specifies commonly accepted values, perceived by himself, that should and do govern collective choice behavior: participation, information, social efficiency, liberty, and rectitude (integrity and equity). Following an analysis of the technical, behavioral, and political realities in *water management*, Fox translates these fundamental values into a set of criteria for the design of decision arrangements:

- (1) An arena is required which will further the development of political leadership on water resource matters;
- (2) The decision arrangement should encourage the sharing of information on diverse preferences and the alternative plans which they represent;
- (3) Each individual should be afforded the opportunity, if not to participate directly, at least to have his point-of-view represented in actual deliberations;
- (4) The decision arrangement should provide the groups affected with the opportunity to bargain with one another;
- (5) Considering time, technical, and economic constraints, the decision arrangements should achieve socially efficient results;
- (6) His next criterion, that of liberty, corresponds to Dahl's criterion of Personal Choice. Each person has the right to expect his preferences to be reflected in the final choice;
- (7) Decisions arrived at should be through a process uniformly regarded as fair and judicious;
- (8) The decision arrangement should ensure effective solutions, that is, solutions which achieve the desired objectives.

Even though Fox's criteria were explicitly conditioned by current trends and his past experiences in water management, his set exhibited a strong correspondence to the more fundamental criteria by Dahl. One feature obviously shared in common was the theme that alternative decisions arrangements should be explored and matched with the requirements of each fundamentally different problem. In one sense, they both mean that different procedures should be studied carefully before a *given* set of rules, which would remain unchanged for the foreseeable future, become finally adopted. This corresponds to those studies intended to identify the institutional and organizational arrangements best suited to the water management problem.

Fox, however, extends this notion to the more technical climate facing contemporary water planners who already operate under fixed decision arrangements. Under such conditions, he recommends that, "For analytical purposes [planners] can apply alternative sets of [decision rules] based upon alternative premises about values" [Fox, 1971, p. 6]. Thus, the arena described earlier and the criteria for judging its performance are in keeping with the spirit of his recommendation. The arena should be viewed, at the very least, as an *analytical* device through which planners can investigate the integrative problem. By exploring the consequences which flow from alternative decision arrangements, winners and losers, a measure of disaggregate costs and benefits, and other features of the integrative problem can be introduced more meaningfully into planning deliberations. Furthermore, if public involvement programs exist, this analytical capability would be strengthened by the existence of more reliable sources of data, more relevant studies of actual group interaction, tighter feedback loops, and so on.

Decision Costs: When to Stop the Search

The arena does not contain within its structure a flag which identifies solutions and signals for the process to stop. There is no guarantee that the arena will converge to a single solution or even a narrow range of alternatives. Instead, by adopting Mode (4), the time of final plan recommendation would conform to the requirements of established decision procedures and would occur when those responsible made their final commitment of resources to implement a specific course

of action. Manheim, however [1972], suggests three conditions under which an active search might reasonably be terminated:

- (1) When substantial agreement has been reached;
- (2) When a complete impasse has developed; or
- (3) When the time, money, and resources of the planning agency have been exhausted.

Substantial agreement. If agreement refers to the set of actors involved in arena activities, then the notion of political feasibility becomes an important consideration in deciding when to stop the search. Dror [1971] agrees that a threshold of acceptability should be required of all plans given serious consideration; but, he likewise cautions against the mistake that feasibility should become the dominant criterion in the sense that "the more feasible, the better" [p. 84]. Instead, predictions of political feasibility should serve primarily to limit the range of seriously considered alternatives. An earlier section on implementation (p. 59) introduced this notion of acceptability and described Bunker's [1972] model for assessing crucial leverage points. Dror [1971] recommends that a panel of experts be consulted, assisted by Delphi procedures, to estimate feasibility. Other approaches such as operational gaming and computer simulation have been described by Bulkley [1972]. In all cases, there seems to be substantial agreement that acceptability is a probabilistic concept and should be expressed as a probability distribution (which may change over time) for each alternative plan considered.

Complete impasse. A deadlock might arise for a variety of reasons. However, one thing would be very clear; substantial

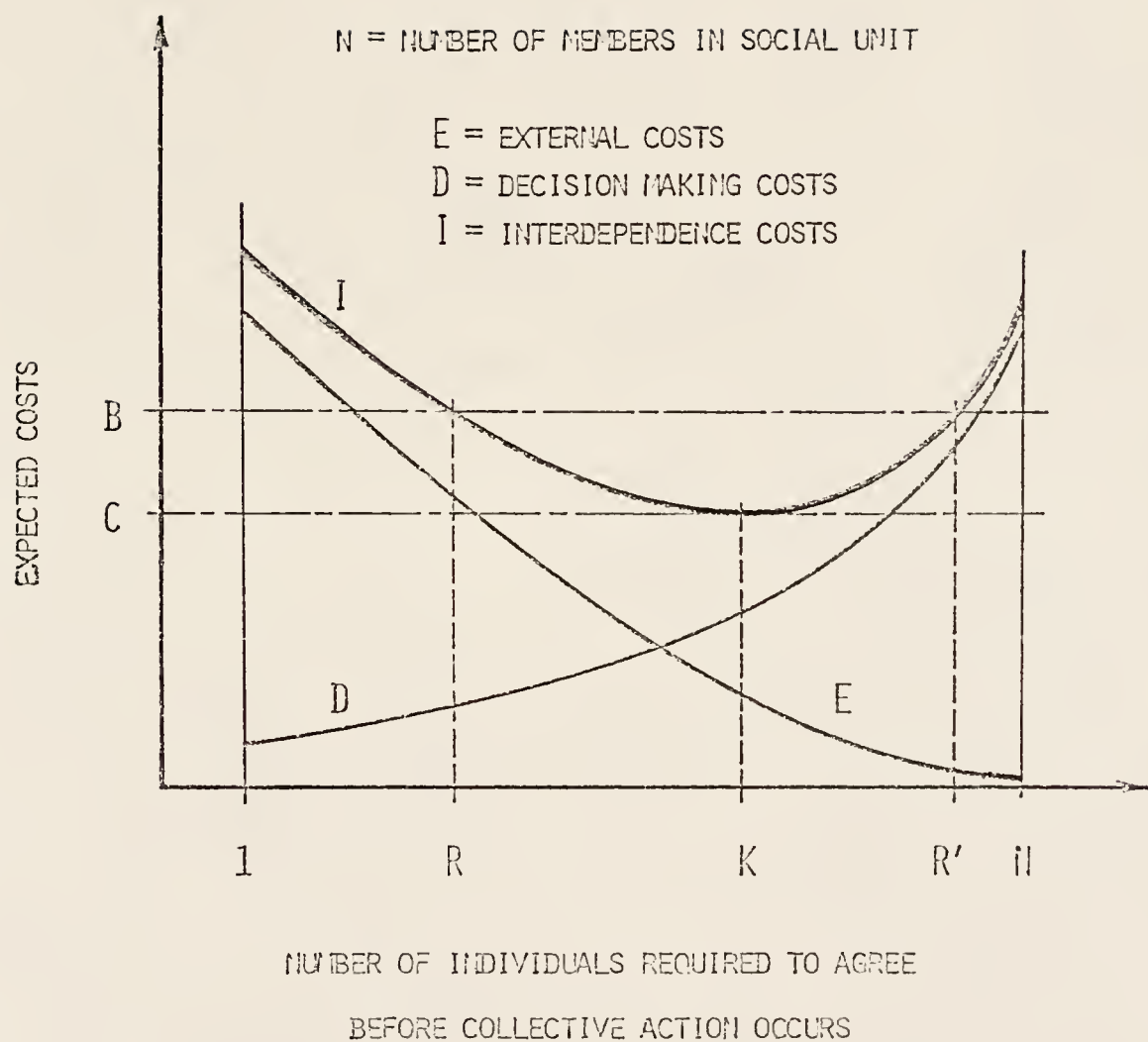
difficulties must exist to the extent that a complete rethinking should be seriously considered. Of course, since Mode (4) does not *require* that the arena resolve any deadlocks, the normal decision channels have the option of selecting any alternative for final recommendation. Yet, the impasse itself conveys certain information which might be used to move issues off dead center. For example, if participants cannot break a stalemate, the problem may contain formidable zero-sum characteristics. Any of the proposals considered might generate distinct winners and losers particularly with respect to deeply cherished values. Neither side would have anything substantial to gain by considering a position other than complete commitment to their own proposal and complete opposition to the other side. Given an impasse of this zero-sum type, rather than abandoning the search, the arena offers a convenient device for *changing the nature of the game*. New proposals could be advanced with the specific purpose of encouraging coordinated effort. If the zero-sum game can be converted to a cooperative game, then each side would stand to gain as a direct result of joint effort. Compromise and compensation could relax the stalemate and provide for the planning agency a means of avoiding the creation of such distinct winners and losers.

Resource depletion. Instead of substantial agreement or a complete impasse, the signal for arena termination would more often than not be an exhaustion of time or resources needed to sustain its operation. Even though another iteration could produce an incremental shift in the proposed plan, losses in time and money would offset any gains, in support or whatever. In terms of Mumphrey's *et al.* [1971]

"political placation" model, the costs imposed by existing opposition would not be reduced enough by additional "add-on" concessions to justify the time or money committed to further search.

In *The Calculus of Consent*, Buchanan and Tullock [1962], present a formalized approach for the analysis of costs associated with collective decision making. (Michalos [1970] describes a more operational check list for accounting decision-making costs.) They define two cost functions which are integral parts of any decision-making arrangement (Figure 4.3). The first, *external costs* (E), are those that the individual expects to bear as a result of other actions over which he has no control. External costs occur in two situations: (1) where the actions of one impose costs on another in the absence of collective action, and (2) where, in the course of collective action, an official's decision imposes costs on others. The second, *decision-making costs* (D), are those which the individual incurs as a result of his own participation in organized collective action. Buchanan and Tullock ignore the purely private cost of reaching decisions; thus, decision-making costs represent the time and effort associated with the activity required for two or more individuals to reach agreement. Taken together, the external and decision-making costs sum to *interdependence costs* (I).

To continue the analysis, these cost functions can be related to the decision rule applied, i.e., both the number of members in the collectivity, and the number required to represent "agreement" on a specific course of action. This proportion can range from *one* (authoritarian rule) to *all* (rule of unanimity). Thus, for external costs (E), the costs would be highest if one person alone were able to take actions



NOTE: If (D) and (E) are Symmetrical, then K Represents a Majority Rule.

Figure 4.3. Inherent Costs of Collective Decision Making
(Adapted from Buchanan and Tullock, 1962)

affecting other members of the collectivity. Such costs would be lowest if all members had to agree before action could be taken, under the assumption that an individual will withhold his consent unless external costs to him are acceptably low.

An opposing trend emerges for decision-making costs (D). If one person makes decisions for the collectivity, transactions costs would be at their lowest. As the number required for approval increases the costs increase until, at the point of unanimity, costs reach a maximum. Figure 4.3 contains a plot of these functions along with their sum (I). Thus, this representation suggests that a collectivity would choose a decision rule, K/N , which minimizes total costs. In this sense, K/N could be called an "optimal" rule and would impose costs on the collectivity of amount (C). Now, assume that collective action under the optimal rule would lead to some joint benefit (B). If it were desired to achieve net benefits equal to or greater than zero, the interdependence cost curve (I) defines the range of allowable decision rules $R-R'$. (Of course, net benefits are maximum at K .) Outside of this desirable range, say at authoritarian or unanimous rules, costs to the collectivity exceed benefits. Thus, a range of possible rules can be in concept defined on the basis of decision costs. Also, each rule within the desirable range would generate a specific set of winners and losers, so that the final rule selection would consider distributive as well as total cost elements.

Ostrom [1971a] and Ostrom and Ostrom [1971] consider the implications of this cost calculus for water management and the appropriate organizational arrangements. At one extreme, we might operate within

a fully-integrated "water" bureaucracy, that is, an ordered structure of authority where command is unified and all agencies and groups rank themselves in a hierarchy of relationships. From the Buchanan and Tullock model, this type of bureaucratic system would be extremely costly, with their speedy decisions offset by the high level of external costs. At the other extreme, a water management system reflecting disjointed, overlapping jurisdictions [Ostrom, 1972a, 1972b] and interactive groups would increase decision-making costs but reduce the external costs imposed by one's actions on others. Analyses like this, based on the Resource Depletion or Economy Criteria, provide useful insight into the questions, when to stop the arena and how to judge its performance.

Summary of "Meeting the Requirements"

This entire section, *Meeting the Requirements*, represented a response to the nine-way typology of decision requirements identified for the general water resource decision problem. In brief, the problem was portrayed as *ill defined, requiring collective action, among unpredictable individuals, focusing on uncertain and conflicting goals*. These features correspond very closely to the problem solved in Parsons' integrative subsystem. Thus, a collective action approach was adopted to emphasize the competition that exists for the allocation of advantages and disadvantages. However, contemporary practices in water management were presumed to lack any mechanism for making collective action visible and readily introduced into planning behavior. To help planners provide for the existence of the integrative problem, a conceptualized arena

was proposed along with criteria for assessing arena performance and guides to suggest when to terminate arena activities. In brief, the arena was presented as a device for exploring the consequences of various collective decision rules, assessing the distribution of positive and negative effects, and in this way assisting in the solution of the integrative problem. Rules and requirements were purposely kept general to provide freedom and flexibility for investigation by planners or whomever assumes responsibility for arena operations. More specific rules can be applied as needs dictate.

Criteria for Analysis of Collective Action Models

The overarching problem, elaborated upon in the foregoing sections and chapters, can be stated as the *aggregation of individual needs and preferences into a specific course of action which is feasible, desirable, and equitable*. Again, the bipolar distinction arises between individual vs aggregate perspectives. However, using the "language of societal action" [Etzioni, 1968], as assumed earlier, both the state-of-the-individual and the state-of-society become legitimate points of investigation. Thus, the specific models to be reviewed can be judged by the way they address the question of equity, the way in which resources are distributed, the public interest, and the manner in which the needs of the social unit are served.

Also, an earlier section outlined the need for a collective action approach, based on the fact that program formulation-implementation and the consequences which emerge are the "resultants of a

complex process of interchange between many persons, groups, organizations, and publics" [Baur, 1973, p. 2]. To partially satisfy this need, a conceptual arena along with criteria for judging and terminating its operations were described. Continuing, this section expands the existing state-of-the-arena by surveying a range of possible *activities*, both participatory and purely analytical, which might be employed in the arena, and at the same time provides a higher degree of formality for the overall study.

To begin, what are we searching for in the aggregation process? Will the arena be used to produce winners, consensus, integration, conflict resolution, cooperation, or what? The overriding objective would seem to be the establishment of patterned, persistent interaction relative to the aggregation problem in a water resource management context. Structure usually develops in most social systems as a response to this requirement. Thus, to address this question, it will be useful to recall the mechanisms of social cohesion (see p. 28); shared norms and values, exchange, conflict, and authoritarian rule. These basic mechanisms, or some mixture, are available to be used directly in arena operations or to help define its purposes for this analysis. (Mayer [1972] describes the implications for planning which are contained in these various factors of cohesion.)

Shared norms and values. If this were the primary mechanism for arena cohesion and organization, then *consensus* would be the dominant objective. In this context, consensus can be defined as the congruence of perspectives and goals of two or more actors [Horowitz, 1962; Lipsitz, 1968; Etzioni, 1968]. Consensus relates to a sharing of

fundamental values and beliefs about what decisions should be made and a general feeling of unity between an individual and the social unit as a whole [Shils, 1968]. Thus, partly because of consensus, the social fabric can tolerate disagreements due to a common acceptance of laws and rules and the institutions which promulgate and apply them.

Viewed in this way, consensus would *not* be a dominant arena objective. It is presumed that members of the arena share certain consensual agreements beforehand; they already agree on generalized aims and the legitimacy of working within the existing system. Hence, their disagreements are *within* the same consensual apparatus, and as such consensus cannot be substantially improved. Of course, one would hope that arena activities would encourage a meeting of minds and a shifting of values toward higher levels of congruence. However, the more dominant reason for the arena's existence is the *disparity* in issue-specific values. It is not likely that such values will shift measurably in the short run; therefore, some objective other than consensus must be sought for arena operations. Put more simply, it is expected that individuals will enter the arena with diverse value systems and will leave the same way. Something other than brainwashing must take place while they are there.

Conflict. Since a presumption of harmony is a fundamental part of consensus theory, the act of "reaching agreements" is not a process which receives much emphasis under that theory [Horowitz, 1962].

But, conflict and resolving conflict are intrinsic to social structure and perform important cohesive functions which were briefly described

in an earlier section. Since conflict exists whenever incompatible activities occur (in the sense that one action makes another action less likely or less effective), then conflict would seem to be a dominant reason for the arena's existence. Furthermore, a "structured" conflict should generally characterize the arena activities.

Rapoport [1960, 1961] has divided conflict into three categories, fights, games, and debates. *Fights* are motivated by mutual animosity or fear and are dominated by the urge to destroy or drive away an opponent. Fights are characterized by the application of weapons, posturing, etc., both physical and symbolic. But, once rational choice enters the fight, the participants move to a level of conflict characterized as games of strategy. In a *game*, each actor foresees a number of possible outcomes resulting from choices which he and his opponent may make [Rapoport, 1961]. Thus, the outcome of any game depends to some extent on an actor's choices; it also depends on acts of his opponent over which he has no control. At this level, then physical conflict has changed to a mode dominated by intellectual activity. Furthermore, games can range from highly competitive zero-sum conditions, in which one actor's gains simply equal the other's losses, to more complicated circumstances involving extra-game factors such as trust, threats, integrity, awareness of collective interests, and so on. At this lower end of the game (conflict) continuum, conflict assumes properties of conviction, socially acceptable behavior, etc., and enters the third level of conflict, *debate*. In a debate the problem is one of convincing another or changing another's outlook. To Rapoport, these three classes form a hierarchy: games are

preferred to fights, and debates are preferred to games. Games do encourage participants to study existing affairs and to consider possible consequences of actions. But, its formulations reduce decisions to the calculation of tangibles based on given values. Debates, on the other hand, recognize the problem of modifying the outlook of others. Mutual recognition of common areas of interest is a problem of *communication*, not of strategy [Rapoport, 1961].

This brief glimpse into the properties of conflict provides a sounder basis for identifying the range of arena activities. First, it can be presumed that conflict, the existence of incompatible activities, will dominate the arena. Then, fights will be excluded. Assuming that few water-related issues are *strictly* zero-sum in nature, the arena would contain primarily cooperative *games* with coalition formation, bargaining, etc., along with *debates* the vehicle for persuasion. *Instead of consensus, the effort would focus on reaching agreements among parties in conflict through cooperation and other measures which resolve conflict.* Thus, models to be reviewed subsequently can be evaluated with respect to the manner in which they address this requirement.

Because of the importance of conflict studies to the thrust of this section, a very brief aside will be taken here. There exists a large body of literature on conflict, the ways in which it can be classified, the manner in which it can be resolved, and many other issues. There is not room here to elaborate on the subject; instead the following few references should serve as an entry to material published on the subject [Coser, 1956, 1968; Boulding, 1962; Rapoport,

1960, 1961; Mack and Snyder, 1957; Koch *et al.*, 1960; LeVine, 1961; McNeil, 1965; Murray, 1968; North, 1968; Nader, 1968; Fink, 1968; Rescher, 1969; Deutsch, 1971; Nelson, 1971; Swingle, 1970].

Exchange. Under the mechanism of exchange, cohesion is established because participants realize the personal advantages to be gained through mutual exchanges. It is *not* expected that exchange relationships would play a dominant role in arena processes. Individuals enter the arena because a conflict in values needs to be resolved not because they expect substantial advantages from exchange. Exchange implies a certain independence of issues whereby one can give up something of less value in return for something he values more highly, and vice versa for other participants. Water-related issues are too interdependent for exchange to take place easily; thus, the arena should not be considered to be a locus primarily for exchange. However, this mechanism will enter to a high enough degree that it should be given explicit consideration. Logrolling, "add-on" placation features of projects, you-vote-for-my-interest-I'll-vote-for-yours, and other exchange procedures must be considered. But, again, this will not dominate the arena and will, instead, be subordinated to a level in which it serves the dominant activity; that is, it will serve as a device to aid conflict resolution.

Authoritarian Rule. It will be assumed that authoritarian rule will not enter the arena in any substantial way. If the proprietor of the arena acts in good faith, this mechanism of cohesion, should have little use except to break deadlocks or to serve in other special instances.

Thus, to recap, the dominant activity to take place in the arena, whether occupied by real actors or investigated (in good faith) with analytical techniques, will be various levels of conflict. These levels will vary along a continuum from *games of strategy* (although not all types) to *debates* which focus on persuasion, learning, listening, shifts in outlook, etc. Ideally, the interactions can be viewed as a "structured conflict," in that the conflict would be managed within limits, thereby encouraging certain more productive avenues and discouraging others. With this dominant focus, the primary objectives of arena operation will be *reaching agreements, cooperation, resolving conflicts, formulating a succession of acceptable deals* [Linville, 1972], *persuasion, learning*, and so on. Other possible objectives like consensus, integration, an equilibrium of exchange relationships, generation of winning and losing sides, authoritarian specifications, etc., will assume a much lower position. Horowitz [1962], in this same spirit, described *cooperation* as a more desirable objective when compared to various implications of the consensus approach:

- (1) *Cooperation* makes no demands for a uniformity of norms and values;
- (2) *Cooperation* focuses on the qualities of action not on the diverse goals and values which may lead to a common action; and
- (3) Instead of seeking unity or unilateral victory, *cooperation* is pluralistic because it makes possible the continuation of differences and even fundamental disagreements.

Equity and "The Public Interest"

Thus far in the analysis, a planning arena has been proposed to help satisfy, in a formalized structured manner, certain primary requirements of the general water resource decision problem. Along with a general description, certain criteria were advanced as a means of assessing overall arena performance, selecting an appropriate range of decision rules, and determining when to cease iterations. Then, the foregoing section initiated the investigation, not of structure, but of the processes and activities that may take place within the arena by specifying the dominant mode of action and associated objectives. It can be tedious to continue with this type of conceptual spadework; however, since the arena is more than a passing suggestion, it would have been irresponsible not to advance formally, at least, minimal descriptions of arena properties.

The section on the analysis of models began with the specification that the aggregation process should lead to actions which are *feasible*, *desirable*, and *equitable*. James and Lee [1971] list five tests of *feasibility* that each water resource program must pass: technical, financial, economic, social, and political. The first three are presumed to be reflected in the information brought to the arena by its participants and as such be somewhat beyond the scope of this analysis. On the other hand, social and political feasibility seem to be more directly related to arena interactions, and thus have a more natural place in the present discussion. Since this type of feasibility was introduced earlier and will be illustrated later, the paragraphs

to follow advance some general criteria to help assess the manner in which the arena (and models to be surveyed) handles *desirability*, expressed as the public interest, and *equity*.

Equity, as a feature to assess directly, has achieved visibility in water resource management only within the last two decades; furthermore, this attention has been in the form of platitudes more often than not. The closest efforts related to this question have been the normative attempts to use "income redistribution" as a goal in water planning. Although this begins to introduce the notion of who gets what, it does not reflect a serious interest in alternative distribution profiles and evades the difficult task of identifying a *just* allocation. More recently, though, there has emerged a keen public concern about just and fair distributions of effects [Gans, 1972]. Since many futuristic projections foresee an intensification of public concern for the question of equity [Wilson, 1970, 1971; Gans, 1972], planners will likewise be faced with the task of investigating the issue in a more explicit fashion.

Urban planners were the first to encounter the rising demands for equity during the emphasis on community action programs in the early 1960s. Even with this experience, definitive or formal studies of this question are rarely found in the literature. However, two planners reflected recently on the basic criteria by which equity may be assessed [Friedmann, 1973; Gans, 1973]: (1) the degree to which all parties affected by a decision are given impartial treatment according to the rules established, (2) distributive justice, or the degree to which fair shares are created, and (3) the degree to which equal

access is provided to the resources needed to participate effectively in the decision process. Isard *et al.* [1969, p. 845] are a little more specific in their recommendations for the basis of a fair procedure:

- (1) Negotiations can be brought to a close within a reasonable number of rounds of proposals;
- (2) Each participant's position in the final solution represents a significant improvement over their initial reference point position;
- (3) Each participant obtains what he considers to be at least his "equitable" fraction of what he perceives to be the total gains; and
- (4) Relative to his own share, each participant senses that no other participant's share is disproportionately large.

Admittedly, these sets of criteria are not very specific, however, they seem to be the best available. Yet, it is not to be expected that a determining set will ever be available, at the outset. Instead, these criteria provide, first, a given set of factors which can be viewed as appropriate measures of equity, and second, a set of minimal standards by which grossly unjust plans may be deleted from further consideration.

Closely related to this problem is the notion of desirability, translated here as a general quest for *the public interest*. For many centuries this has been the classical question in debates concerning public affairs. No solution has been found and none will be advanced here. However, certain basic approaches to identify the public interest can be spelled out in a manner that will serve as a means for assessing the arena and the models employed within it. It may not be possible to convince all arena members to adopt the same approach; however, as a means for organizing interactions it will be useful to

identify the different approaches or mixtures which came into play. Several sources provide a useful introduction to the subject [Schubert, 1960; Meyerson and Banfield, 1955; Friedrich, 1962; Flathman, 1966; Downs, 1962; Harmon, 1969; Steiner, 1970]. Reviewing the vast literature specifically directed to an analysis of the public interest reveals at least three basic modes for identification which appear consistently:

Rationalist. In the rationalist mode it is first assumed that a substantive, discoverable public interest does indeed exist. After this, the public interest is presumed to be revealed by a summation of individual preferences through opinion polls, majority votes, adding individual utilities, etc. Elected representatives, a product of due process, then execute this popular will. With reference to water planning, this mode would apply whenever plans conform to guidelines issued from higher authority, if the authority reflects views of the representatives of the popular will. Various Federal guides such as the *Green Book* [U.S. Interagency Committee, 1960], *Senate Document 97* [U.S. Senate, 1962], and *Circular A-47* [U.S. Bureau of the Budget, 1952] infuse water planning with this philosophy. Also the use of scientific techniques, such as PPB and systems analysis, to rationalize the application of broad policies generate plans which fall primarily into this category.

Idealist. This mode also presumes that a substantive, discoverable public interest exists, but here, it is not necessarily related to individual or collective preferences. One cannot rely on majority vote or public opinion polls, because individuals may or may

not perceive their true interests. Instead, the public interest resides in some higher natural law not in a description of preferences. Thus, the superior intelligence of public officials, planners, and trained specialists are best suited for revealing those plans which are in the best public interest. With reference to water resource planning, this mode probably dominates all others. Complex problems, especially those with a prominent technical component, often become subsumed by the idealist mode.

Pluralist. The pluralist mode begins with the assumption that no substantive, discoverable public interests exists. Instead, the public interest is a residual. It is the result of a process which permits everyone to have his view meaningfully represented. Often, this mode refers to group interaction by which, it is assumed, an individual's interest are best revealed, focused, and protected. Many water programs stand or fall as a result of pluralist group interaction. The emerging emphasis on advocacy planning, public participation, and other forms of group access to the planning process suggest an intensification of this mode for revealing the public interest.

It is apparent from these descriptions that a single mode will seldom exist by itself, and that planning behavior will reflect a fluid mixture of all three. There is no necessity to specify here which mixture would be the preferred one; however, it will be useful to be able to identify and describe the mode being used. Meyerson and Banfield explain that, "A somewhat different decision-making mechanism is implied by each of these conceptions of the public interest" [1955, p. 327]. Thus, the nature of the choice mechanism employed determines

in part the content of the public interest, and as such the public interest question can be suitably discussed in terms of the appropriate mechanism of choice. This becomes particularly important when the conditions under which the arena is managed (or analytically investigated) are scrutinized.

Harmon [1969] has provided a means for scaling an agency's approach to the public interest. In Figure 4.4, he plots two of the three public interest modes, rationalist and pluralist, as a policy formation grid. If the degree to which an agency conformed to a given mode could be scaled, say from 0.0 to 1.0, then for a certain issue the agency's position can be located. Adding other dimensions, like the idealist mode, permits an expansion of this descriptive tool and would encourage evaluations of the manner in which agency procedures constrain the types of plans that can emerge.

With the arena in mind, Harmon's analysis begins to suggest a range of possible *stances* which the arena operator may take; with each stance suggesting different possible outcomes. Bishop *et al.* [1969], drawing upon the work of Bolan [1967], touch upon this issue and outline various arena strategies:

- (1) *Strategy of information*, planner only contacts participants individually for information;
- (2) *Information with feedback*, planner collects the information and controls the amount exchanged among groups;
- (3) *The coordinator*, planner coordinates his activities with various groups but discourages intergroup interaction;
- (4) *The coordinator-catalyst*, planner stimulates interaction among community groups, e.g., by workshops including all interested parties;
- (5) *Community advocacy planning*, each community interest has a representative in the planning process;

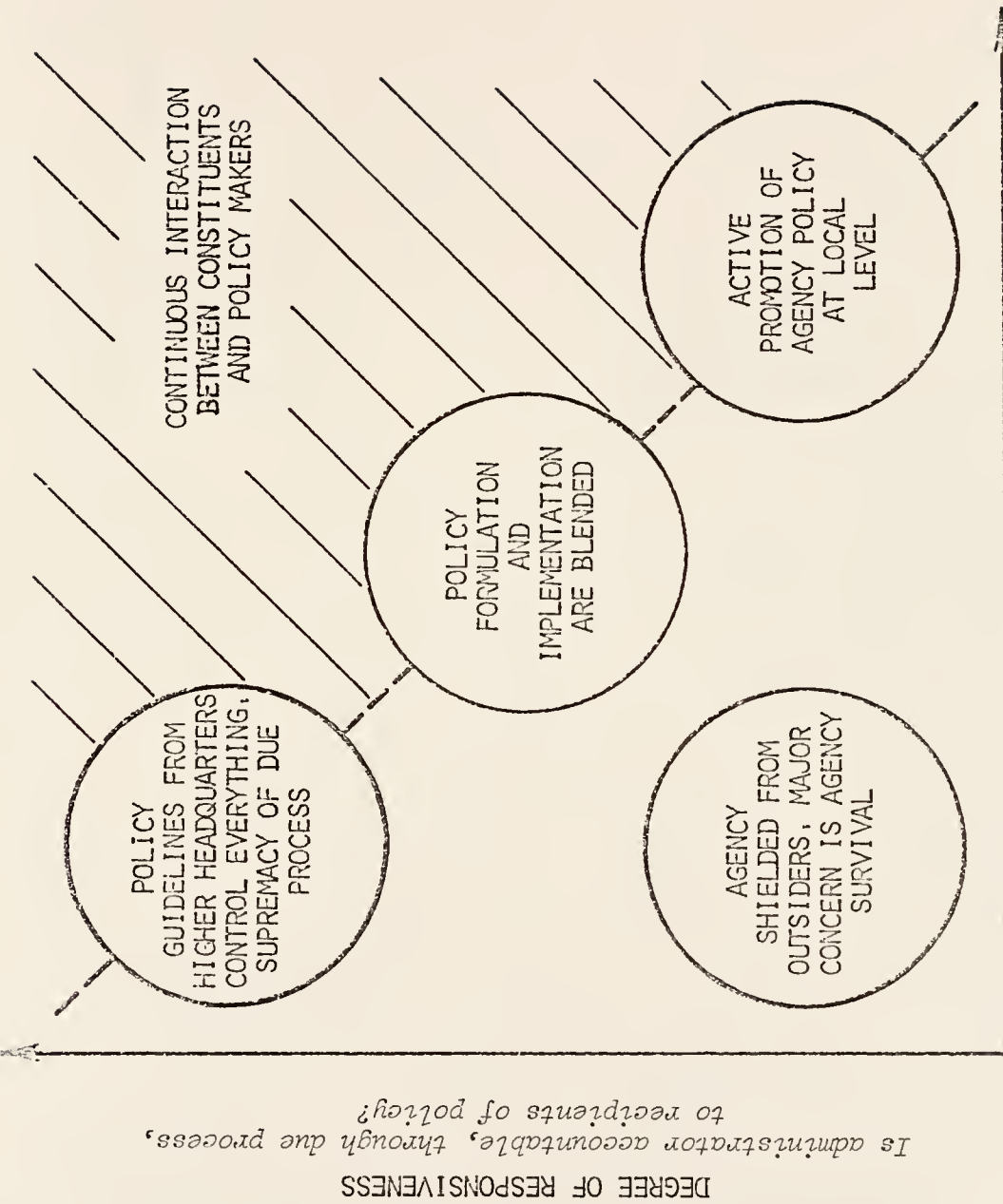


Figure 4.4. The Administrative Policy Formation Grid and the "Public Interest"
(Adapted from Harmon, 1969)

- (6) *Arbitrative planning*, an independent party manages the arena with specific intention of settling disputes; and,
- (7) *Plural planning*, each group has its own planners and submits them during arena operations.

A Survey of Collective Action Models

Assuming the requirement for a collective action approach, the foregoing sections (1) described a conceptualized arena, (2) suggested how it should be viewed, (3) summarized its purposes, outlined criteria for (4) assessing its performance and (5) deciding when to terminate its activities, and (6) reviewed an approach for selecting a range of decision rules. This portion of the analysis thus began to formalize the arena's *structure*. Subsequent sections focused more directly on *process* characteristics by (1) identifying the dominant mode of arena activity, (2) specifying, within this mode, the general purpose of arena operations, and (3) outlining criteria for assessing the process as it relates to equity and the public interest.

Taken together, this minimal exploration of arena structure and process should provide a conceptual base by which the arena can be interpreted as a mechanism for aggregating preferences, action, and decisions of individuals into a single expression. As such, the arena can be viewed as a mechanism for social choice. Throughout this work social choice, public decision, collective action, and other related terms have been used interchangeably. There is a real distinction; however, the difference matters little in this study. Thus, a *model* of collective action (social choice, or public decision) can be defined

as a set of statements describing the way in which individual choices are transformed into collective decisions [March, 1966].

The following section begins an introduction to collective action models which range from formal, mathematical approaches for the analysis of different modes of collective behavior to statements which describe procedures for actual human interaction within an arena setting. To help relate diverse models to various arena requirements a loosely formed classification scheme will be followed. First, March's [1966] generalized classification separates models on the basis of their approach to social and political power. Within this typology, each model can then be viewed (1) as a normative *prescription* or (2) a behavioral *description* of collective action.

It will not be possible to fully review all models that meet these requirements. Nor will it be possible to explore each approach in substantial detail. Instead, an illustrative sampling has been selected to provide the flavor of widely ranging methods. Furthermore, not all of these models can be viewed as technically operational; however, each has its own contribution to make to the general water resource decision problem and should be assessed in this light. Also, a number of models, especially of the nonnormative type, tend to be verbally rigorous compared to the mathematical normative techniques. For the following survey, this characteristic was not assumed to reflect seriously on a model's operability; hence, a verbal model may exhibit a higher degree of operability than detailed mathematical techniques.

Power

The explicit consideration of social and political power is essentially nonexistent in those activities which are commonly referred to as water resource management. Yet, power can be viewed as one of the key ingredients in social decision making. Etzioni [1968, p. 301] observes that collective decision making is "not merely a thought-process that balances goals and means but also a political process that balances various power vectors." He emphasizes his position by stating that, "A decision-maker may choose . . . to ignore facts, but--by definition--he cannot ignore power" [p. 303], and that, "it should be noted that unless we add power analysis to that of decision making, we do not know how decisions are related to the control of action" [p. 304].

Most will agree that power in a social decision context enters calculations in a very prominent manner. However, planning may be conveniently viewed as a subsystem of the societal overlayer (Figure 3.1, p. 85); thus, it may be legitimate to consider water resource planning as essentially free of any requirement to *acknowledge* power. However, although possibly free of a *requirement* to investigate power, power still invades all phases of planning. For not only does a planning agency, almost by definition, sustain a certain measure of power, also every act including control of the agenda, expressions of expertise, etc., generates a succession of power-laden actions.

March [1966] has provided an excellent survey, *The Power of Power*, in which he evaluates the usefulness of "power" as a concept to help understand social choice mechanisms. To him, "the class of social-choice situations in which power is a significantly useful

concept is much smaller than I previously believed" [p. 68]. Thus, March believes that any headlong commitment to "power" as a vehicle for understanding social choice may be irresponsible. Yet, one cannot ignore the spectre of power which infuses planning, in that, "Power is at the heart of every argument with which planning is concerned" [Ozbekhan, 1968b, p. 153]. Also, Friedmann, a prominent planning theorist, feels that the planning process, "refers to the *allocation and uses of power*" [1973, p. 5].

The last two remarks are consistent with the lines of development in this study, and so power will continue to occupy a substantial position in the concepts presented earlier and in those to be proposed later. It is presumed that planning by definition implies power and that planning behavior requires the explicit recognition of power dynamics. But, given these assertions, March's thought-provoking analysis will not be ignored, and power considerations will not be advanced as a remedy for all planning ills. However, a continuing disregard of this factor would be as unreasonable as a total commitment, since March's analysis also reveals that power can be a useful concept for many short-run conflicts involving more direct confrontations of committed and activated participants. One might interpret the water resource management problem as essentially this type of situation especially after the introduction of the conceptual arena.

Defined at a high level of generality, power may assume the role of an intervening variable between an initial state, defined in terms of individual actors, and a terminal condition, described by the state-of-the-system [March, 1966]. In this sense, power is that

"stuff" which enters the process of individual interactions as they seek to establish a commitment to a single course of action. Etzioni [1968, p. 314] describes power more specifically as the capacity to overcome friction or resistance to proposed changes in the face of opposition. In a stricter collective action sense, power measures the capacity of each individual to ensure that the decision emerging from his social unit conforms to his personal preferences [Leoni, 1957]. Dahl [1957] has proposed a more concise interpersonal definition by referring to power as the *probability* that actor A can get actor B to do something that B would not do otherwise.

Many other definitions of power have been advanced, however, Coleman [1968] explores a realm of power which more closely expresses the conditions reflected by the general water resource management problem. In this case, "the decision governs an *action* to be taken . . . by the collectivity, an action that has a fixed profile of consequences for the members" [p. 10]. Because of this fixed profile, power does not concern the division of spoils, nor in this sense is power concerned with the power of members vis-a-vis one another. It's not a matter of how much power, say, developers may have in making conservationists or other actors do their bidding. Instead, the important concepts involve members and the ability of the collectivity as a whole to act. The power of the collectivity to act may be small or large depending on the number of required interactions which lead to action by the collectivity as a whole. A companion to this conception is the power of each member vis-a-vis the acting collectivity (again, not vis-a-vis another member). That is, one's power to *prevent* action,

and his power to *initiate* and push through action by the collectivity. Thus, we have (1) power of the collectivity to act and (2) power of members vis-a-vis the acting collectivity. In general, interpersonal power becomes less prominent.

Much more needs to be said of power in addition to the minimal definitions presented above. For example, (1) what are the elements in an analysis of power, (2) how is power related to decision and action, (3) how may power be classified, (4) how can power be measured, (5) is power exerted, different from potential power, (6) can power be viewed as conservative, plus many others. Many of these questions have been studied seriously only since the 1950s [Dahl, 1968]. But, even though students of power remain somewhat unsatisfied with the progress of their analyses, there now exists a vast collection of findings and techniques which would be directly useful to water resource management, particularly within the framework advanced by this study. Hopefully, some of this literature can be included in the following survey of models. Realistically, though, only those power-related factors intimately associated with each model will receive adequate exposure. As with conflict earlier, it is felt that power should receive much more attention as it relates to water planning. Space here does not permit adequate analysis; therefore, the following general entry into the literature is provided to stimulate and encourage future inquiry [Dahl, 1957, 1968; Cartwright, 1959a, 1959b, 1965; French and Raven, 1959; Banfield, 1961; Karlsson, 1962; Schopler, 1965; March, 1955, 1959, 1966; Parsons, 1963a, 1963b; Blau, 1964b; Clark, 1968; Hawley and Wirt, 1968; Etzioni, 1968; Coleman, 1968; Bell *et al.*, 1969; Raven and Kruglanski, 1970; Olsen, 1970].

A Classification of Models by Their Approach to Power

Power, then, is integral to planning and is a requirement in the analysis of planning behavior. Thus, in the survey of collective action models, a classification scheme based on power should serve a valuable function. March [1966] has identified six types of social choice models distinguished by the manner in which the concept of power is embedded in their structure:

- (1) *Chance models*, which assume that choice is a chance event, quite independent of power;
- (2) *Basic force models*, which assume that actors exert *all* their power on the system with choice being a direct resultant of those powers;
- (3) *Force activation models*, which assume that *not* all power of every actor is exercised at all times;
- (4) *Force conditioning models*, which assume that the power of actors is modified as a result of the outcome of past decisions;
- (5) *Force depletion models*, which assume that the power of actors is modified as a result of the exertion of power in past choices; and
- (6) *Process models*, which assume that choice is substantially independent of power but not a chance event.

Chance models. In this group, it is assumed that the outcome of a decision process is not affected by human characteristics. Moreover, chance factors are the only influences affecting choice outcomes. For example, given an array of decision alternatives one might define a probability function which identified the likelihood that a certain alternative would emerge. Any function is permissible as long as actor characteristics and preferences do not enter. Another type, assumes equal power among actors along with specified initial positions.

An outcome, in this case, is the equal-power solution (usually an arithmetic mean of initial positions) along with some error term. According to March, the simplest error term would be normally distributed with mean zero and variance equal to some function of the variance of initial positions. A third chance model refers to the encounter between two opposing groups in a social choice situation. Circumstances are such that one side wins and the other loses with a certain probability at each encounter. Usually, the probability depends on relative sizes of the groups in question.

These models are very naive with assumptions that violate an observer's intuition. However, a surprising number of individual and collective choice outcomes demonstrate a random or probabilistic tendency. Their primary use, though, would only be to predict outcomes since they do not encourage an investigation of behavioral and environmental factors with known consequences for social choice.

Basic force models. First, assume that power is real and has consequences for decision outcomes. The simple force models specify that collective choice outcomes are a weighted combination of individual positions; weights equal the power associated with each actor. (The equal-power case here may fall into the previous category.) Power is assumed to be constant over time and fully exerted. Let D_j be the social choice on the j th issue, and x_{ij} be the position of actor i on issue j . If p_{ij} represents the relative power of actor i on issue j , then the social choice,

$$D_j = \sum_{i=1}^n (p_{ij})(x_{ij}) \quad \text{where, } n = \text{number of actors.}$$

Thus, given a set of power ratios and initial positions, the collective choice can be defined. Conversely, given D_j and x_{ij} the distribution of power can be investigated. Models such as this have continuous, discrete, and probabilistic variations, but all use this newtonian concept of continual and completely applied force. Students of power agree that power is neither constant over time nor completely exerted at all times. The three models to follow attempt to correct for these deficiencies.

Force activation models. Let f_{ij} equal the fraction of the total power resources of actor i which are exerted at a given time over issue j . Using this, the fact that some actors choose to exert themselves to different degrees over various propositions can be introduced into the basic force model,

$$D_j = \sum_{i=1}^n [(f_{ij})(p_{ij})] x_{ij} \quad \text{where, } n = \text{number of actors.}$$

This model begins to explore the argument of *potential* power versus *exerted* power, and, at the very least, assumes that they can be unequal. Included in this formulation are measures of degrees of activation of various actors plus the opportunity for each individual to exert power to the point that his marginal losses equal marginal gains. The temptation also exists to use activation models to explain outcomes where the apparent weak succeed over the strong because of variable f_{ij} 's.

Force conditioning models. Studies show that people can have power because, as a result of past decisions, others believe that they have power. Hence, by replacing the constant power term with a time-varying one, the model begins to incorporate consequences of perception,

learning, etc. Assume that social choices are ordered by their time of occurrence, $D_1, D_2, \dots, D_t$. Power, then, is a function of previous outcomes in the sense that power vectors are reassigned after each choice. At that time, information is available on choice D_t and the previous power vector $P_{t-1} = (p_{1,t-1}, p_{2,t-1}, \dots, p_{n,t-1})$, thus the task becomes the assignment of a new power profile, P_t . Depending on the criteria used to adjust power to the new reputation for power, the outcome of the next social choice encounter becomes a function of P_t . Also, the dependency on time begins to suggest Markov or other types of stochastic techniques for collective action analysis.

Force depletion models. For the conditioning model, success breeds success; previous victories increase the chance of future triumphs. It's possible, though, for success to breed failure. Banfield [1961] describes the manner in which resources for power can be consumed by a sequence of decisions. Each decision requires the expenditure of power to overcome the friction of opposition, thus power varies and decreases over time.

For a one-step case, $p_{it} = p_{i,t-1} - (f_{i,t-1})(p_{i,t-1})$

or, $p_{it} = p_{i,t-1}(1-f_{i,t-1})$

For the multi-step case, $p_{it} = p_{i,t-n}(1-f_i)^n$

at a constant withdrawal rate.

Power used at time t means less power is available for time $t+1$ unless exogeneous power resources are solidified into the actor's profile.

Thus, at each step the social choice is a function of p_{it} which varies from encounter to encounter.

Process models. Now, suppose that power is a factor which does *not* have consequences for collective action outcomes, but outcomes depend on factors other than chance. It is within this category alone (unfortunately) that most available models of collective choice fall including many to be surveyed in more detail next. Using March's [1966] breakdown, under this general category, a brief preview can be provided:

(a) *Exchange models.* Assume that a social unit has a given criterion for making social choices, and that a medium of exchange exist by which actors can make deals that are personally advantageous. These deals along with the decision rule determine the social choice. The free market along with the general economic model provide examples of collective action mechanisms with no implied power profile (except a balance of power with equal shares). Certain game theory approaches and models of vote trading and logrolling incorporate, at most, very weak power considerations. More elaborate exchange models of social choice can be found in *An Economic Theory of Democracy* [Downs, 1957], *The Calculus of Consent* [Buchanan and Tullock, 1962], and *The Theory of Political Coalitions* [Riker, 1962]. Homans [1958, 1961], Blau [1964a], Coleman [1964a], Olson [1965], Bartos [1967], and Salisbury [1967] use the mechanism of exchange to explain collective action in organizations and smaller groups. Exchange models are somewhat easier to put into mathematical, quantifiable form which may explain why they also disproportionately outnumber other categories. Even so, they can provide a wealth of useful informatin so long as it is remembered that a variety

of important categories exist beyond the process (exchange) group, categories which do not overlook power as a determining factor.

(b) *Communication-diffusion models*. Here, we assume that actors are connected by formal and informal communication networks by which information diffuses through the system. If some process of information exchange is postulated, modifications in behavior can be predicted leading to a single social choice position. Perhaps the most comprehensive study of this process has been performed by Everett M. Rogers in *Communication of Innovations* [Rogers and Shoemaker, 1971]. This book summarizes existing literature in this area and formulates a series of propositions and models which describe the way in which social choice positions evolve [Rogers, 1971]. Although not quantitative, his generalizations could serve as the basis for standards and procedures relative to arena activities.

Two research centers have studied public works activities from the standpoint of this model: first, the Department of Geography of the University of Chicago, for example, *Diffusion of the Decision to Irrigate* [Bowden, 1965] along with many others; and second, the Department of Sociology and Anthropology of Iowa State University who have studied among others, the *Diffusion of Fallout Shelter Innovations* [Klonglan *et al.*, 1970]. Other more scattered studies have evoked the communication-diffusion model in water resource management, namely, Andrews and Geersten [1970], Peterson [1971], York and Baskett [1971], Wilkinson [1972].

(c) *Decision-making models* (sic). These models seek to understand social choices in terms of the realities of decision-making climates including (1) an *overload* of demands within available time and (2) *undercomprehension* of the complexities involved. Earlier forms of this model are usually identified with Herbert A. Simon [1955, 1957a] who formalized the process by which humans deal with real world problems. Instead of rationally considering all possible alternatives and calculating all of their consequences, Simon shows the people "satisfice" or pick courses of action which are "good enough." In collective circumstances, decision makers will consider those alternative solutions which "come to mind" and express a commitment toward the one that everyone can "agree on." Charles E. Lindblom, in his now classic article *The Science of "Muddling Through"* [1959], continued in the Simon vein and contrasted his (Lindblom's) disjointed incrementalism with the strict rationalist approach to collective decision making. Under disjointed incrementalism planning progresses in an experimental exploratory fashion; movement takes place in smaller, slowly moving steps which reflect the give-and-take or mutual adjustment among actors with power. Much interest is expressed in this model of collective action not only because it describes the politics of compromise and coalition, but also because it represents a prescription for action in pluralists societies. Further analyses can be found in Braybrooke and Lindblom [1963], Lindblom [1965, 1968], Etzioni [1968].

Cyert and March [1963] have extended these decision-making (sic) concepts to organizational behavior in their *A Behavioral Theory of the Firm*. In the area of water resource management, several authors have

studied regional water-related decision making and find the same overlapping, disjointed incrementalism reflected in these decisions [Kasperson, 1969; Howards and Kaynor, 1971; Urban Systems Research and Engineering, Inc., 1971; Doerksen, 1972; Ranney, 1972]. Their findings along with the basic underpinnings of incrementalism have valuable implication with regard to the arena and its basic structure.

Models of Collective Action With Normative Tendencies

The aggregation of individual preferences into a single expression of collective choice has been described as one of the most fundamental problems, as yet unsolved, in social science [Davis and Hinich, 1968]. One of the primary difficulties arises because of the so-called Condorcet effect or the paradox of voting in which, even if individual preferences are transitively ordered, there may arise reasonable circumstances under which majority voting cannot produce (without subverting the voting procedure) a transitive social ordering or a uniquely preferred choice. In his *Theory of Committees and Elections*, Duncan Black [1958] rediscovered this paradox and helped revitalize modern scholarly interest in the basic problem. For this reason, Riker [1961] feels that Black's essay is one of the most important works of political theory published in this century. Following Black's reopening the issue, Kenneth Arrow [1951] published the now-classic *Social Choice and Individual Values* in which he proved the General Impossibility Theorem: if certain reasonable conditions are placed on the procedure for translating individual into collective preference (i.e., the social welfare function), then no function exists which can invariably produce a social preference.

This theorem seemed to destroy the foundations of normative welfare economics and democratic political theory and, as such, has generated widespread interest in the basic aggregation problem. A current and more accessible restatement of the issue can be found in *Games and Decisions*, Chapter 14, by Luce and Raiffa [1958]. Riker [1961] provides a useful bibliographic essay; and Vickrey [1960] examines the conditions of the impossibility theorem within the context of real-world requirements for collective decision making. More recent theoretical expansions on the fundamental works of Black and Arrow have been provided by Downs [1957], Farquharson [1969], Sen [1970], and Pattanaik [1971].

Primarily, these works have used precise logic and sophisticated mathematics to prove essential theorems and to investigate important components of the aggregation problem. As such, they can be viewed as analytical normative approaches to the question, how should a collective decision mechanism operate to satisfy certain reasonable requirements? Hence, these basic works set the stage for the review of normative models to follow. Several of these models are direct attempts to solve problems posed by the impossibility theorem; others, including models in the behavioral section, address the same fundamental issue but may not be a direct response to Arrow's work.

Mathematical Approaches. Works described in the previous paragraph are, of course, also mathematical; they lack, however, an operational flavor and use a restricting unidimensional perspective. The models in this section tend to retain a focus on rigorous mathematics but have a more functional bearing on the problem in this study.

Spatial models. Davis and his co-workers [1966, 1967, 1968, 1970] extend the analysis to include multidimensional aspects of the problem using methods from linear algebra and multivariate statistics. Their objective was to develop a theory which explains how candidates do act or ought to act predicated on citizens' responses to the candidates' position. Thus, what position should a candidate for election assume in order to ensure his election. This approach can be restated to meet the needs of water resource management in this sense, (1) which plan (candidate) will be picked by a collectively acting group or (2) which plan most closely represents the group preference. The authors assume that each individual first evaluates the plan in terms of his own preferences, then decides whether to vote for the plan or not. So, let

$\underline{x}_i$ = position vector of individual i ,

n = number of attributes along which a plan will be judged,

x_{ik} = preferred level of attribute k for individual i ,

then

$$\underline{x}_i = [x_{i1}, x_{i2}, \dots, x_{in}]'$$

Each plan as well as each person can be characterized by a specific measure along each plan attribute.

$$p_j = [p_{j1}, p_{j2}, \dots, p_{jn}]'$$

Thus, plan j can be represented by a point in an n -dimensional coordinate system along with points representing each individual. The common coordinate system also provides a means by which each person can

decide if he favors P_j : the closer $\underline{x}_i$ is to P_j the more the plan is favored and vice versa. If multiple P_j are available, each individual votes for the closest one using, for a simple example, a quadratic loss function as his measure of satisfaction.

$$L_i(P_j) = [\underline{x}_i - P_j]' A [\underline{x}_i - P_j]$$

where A = a matrix of weights associated with each dimension.

Now, given this formulation one can proceed to answer a variety of questions. For example, as a planner which alternative should I recommend if I wished to minimize the total sense of loss felt throughout the social unit.

$$\text{Minimize } E[\underline{x}-P]' A [\underline{x}-P] = t_r A + |P-\underline{\mu}|$$

$$\text{where } t_r A = \text{trace of } A = \sum_{i=1}^n a_{ii}$$

and, $\underline{\mu} = E(\underline{x}) = \text{mean of all positions.}$

Other questions can be posed, for example, which plan from a *set* of plans should be picked. This formulation provides a method for assessing certain parameters of interest among the collective decision groups. Various assumptions about decision behavior can be studied with respect to their effect on various outcomes. Davis, Hinich, and Ordeshook [1970] provide a detailed assessment of these features along with a critique of the assumptions employed. This need not be covered here, but the formulation above does provide useful structure and notation for concepts to be presented in Chapters V and VI.

Conflict resolution. Conflict and conflict resolution have received a surprisingly large amount of sophisticated mathematical treatment. Saaty [1971] reviews a number of these focusing primarily on models of war. Remembering Rapoport's [1961] three modes of conflict, fights, games, and debates, and the type of regulated conflict appropriate to the conceptual arena, helps to bring the impact of Saaty's analysis into clearer focus. First, the elimination of fights from arena consideration would make, of course, his survey of models less applicable; but their current level of development strongly suggests movement into lower levels of conflict in future efforts. Also, another conclusion from his analysis has more direct bearing on the purposes for our survey of models. Namely, that conflict resolution has a better future if embedded in lower levels where there is a framework for joint cooperative effort. The reason for this is that conflict often can be resolved only by changing the game, and the game typically becomes easier to change as one moves down the conflict hierarchy. Furthermore, Saaty states that, "Long-range conflict resolution may therefore involve people coming to see that together they form a larger open system in which certain forms of conflict play a creative role"[p. 10]. This adds support to the focus of arena activities on controlled conflict and provides encouragement relative to the possible development of analytical tools.

Lexicography. An earlier section emphasized the multidimensional nature of the water management problem. Also, the model above by Davis *et al.*, retained full-dimensionality by assuming that each individual judged alternative plans on the basis of a set of n components or

criteria. However, as the authors noted, quite often individuals base their decisions on a subset of n -dimensions or on a sequential process of individual comparisons. This approach has been named *lexicography* and represents only one of an array of multidimensional decision techniques [MacCrimmon, 1968, 1973]. At this point, its primary relevance rests its qualification of the Davis approach, and more important, with its formalization of concepts to reappear in Chapters V and VI.

The lexicographic principle supposes that each individual has a salience ranking of the n policy attributes. In many important areas, humans reduce decision problems to a subset of highly salient dimensions and then proceed with their analysis by sequential comparisons. Taylor [1970] has studied the aggregation problem of Arrow and modified Davis' *et al.*, approach using lexicographical orderings. Using a formal statement, the n policy dimensions are ordered by individual i into a position vector, where x_{i1} is preferred to x_{i2} , and so on.

position vector $\underline{x}_i = [x_{i1}, x_{i2}, \dots, x_{in}]$.

He prefers plan A to plan B and only if,

$$|x_{ij} - x_{Aj}| < |x_{ij} - x_{Bj}|$$

and,

$$|x_{ik} - x_{Ak}| = |x_{ik} - x_{Bk}| \quad \text{for all } k < j, \text{ for some value of } j.$$

Hence, he prefers A to B if A's first component is closer to x_{i1} than B's first. If x_{A1} and x_{B1} are equal, he proceeds to the second most salient dimension and compares x_{A2} and x_{B2} against his preferred position x_{i2} , and so on until one plan wins.

Models of Voting, Strategy, Coalition and Bargaining Behavior.

Black's [1958] analysis in *The Theory of Committees and Elections* focused primarily on voting problems in small committees. He revitalized interest in the Condorcet effect and proved that majority voting could absolutely guarantee a unique social ordering only if individual preferences functions were single peaked (inverted teacup) and arranged along a single dimension. Since many alternate conditions to this can be imagined other approaches must be investigated relative to their ability to address the problem of aggregation.

Voting. Voting as a social decision mechanism has been studied and restudied for many years. For example, in addition to Black's [1958] work on small committees, Dahl [1956] in his *A Preface to Democratic Theory* analyzed the normative theoretical details of voting in large collectivities. Buchanan and Tullock [1962] extend the analysis of voting, especially majority voting; while an analysis of the imperfections in voting procedures have been described by Tullock [1959], and Ward [1961] for small voting bodies, and by Mitchell [1962] for large collectivities. When viewed in relation to the conceptual arena, these analyses of voting advantages and disadvantages become more important. For, not only would one be interested in different ways of managing the voting agenda, also it would be useful to see what biases this collective mechanism introduces into the analysis. For example, voting is better suited to cases where a variety of independent, cross-cutting, unrelated issues must be considered. Here, the individual realignments over diverse issues reduce the tendency for long-run block domination. But, as the variety of issues decreases the same

majority tends to dominate activities for long periods. Haefele [1970] shows this to be true in single purpose commissions. As a case in point, river basin commissions tend to consider an issue specific agenda and thus induce dominant majorities which persist over time implying certain inequities *inherent in the decision rule*.

Rae [1969] provides a more specific analysis of voting rules, as this type of analysis might apply to the conceptual arena. He reveals that more than one voting rule may be used, in fact, the number of different rules equals the number of members in the voting body. They range from $k=1$ where a single person can initiate or stop action to $k=n$ where action is taken only under unanimous agreement. Furthermore, "one can hardly claim to have identified the 'best' decision rule . . . unless he has shown it superior to the $n-1$ alternatives" [p. 40-41]. Rae also provides a model to guide the analysis of alternative rules. First, identify the four possible outcomes of any vote relative to any voter i , that is, he votes "yes" or "no" and the plan passes or fails. Any typical voter would prefer that decision rule which minimizes his chances of losing and maximizes his chances of winning over the long run.

	VOTE YES	VOTE NO	
PLAN PASSES	Win W_1	Lose L_1	Maximize $\Pr(W_1+W_2)$
			or
PLAN FAILS	Lose L_2	Win W_2	Minimize $\Pr(L_1+L_2)$

Take for example the objective of minimizing the probability of losing. This objective has two parts: (1) the probability that a plan is imposed against his will and (2) the chance that his desires are rejected. Thus,

$$\text{Probability of Losing} = c_1 \text{Pr}(L_1) + c_2 \text{Pr}(L_2)$$

where

$$c_i = \text{weight he assigns to the } i\text{th way of losing.}$$

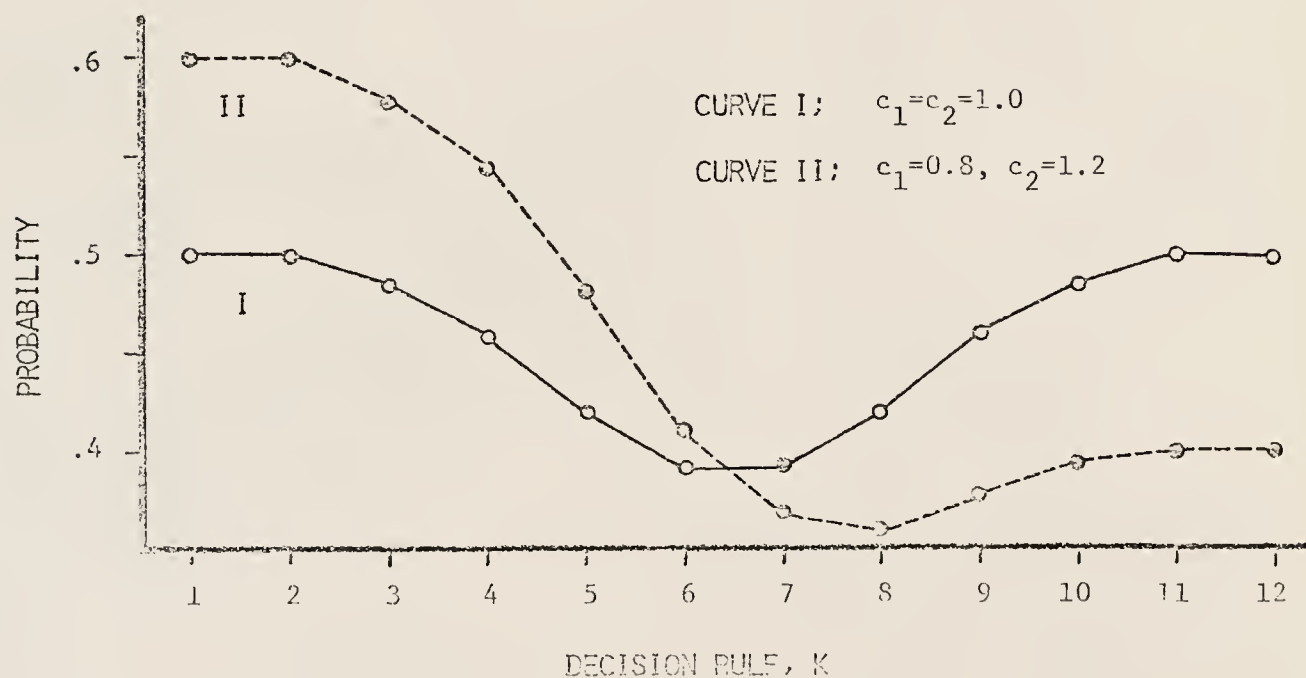
If c_1 and c_2 are equal to 1, that is, he is concerned equally about both ways of losing, the resulting probabilities would be those presented in Table 4.3. This table is reproduced from Rae [1969, p. 50] to be available for consultation in Chapters V and VI. But, in this immediate context, the tabulated values also permit the inspection of the optimal decision rule for a voting body of size n . In each column the optimal rule corresponds to majority vote for odd n and majority vote along with an adjacent value for even n . Thus, majority vote seems to minimize a typical voter's chances of being disappointed over the long run. (This, of course, ignores the many imperfections observed in voting conditions for large elections.) Another feature of this type of analysis is of interest here. Suppose a voter has a $c_1 < c_2$; that is to say he would rather have his preferred plans voted down than to have "bad" actions railroaded over his objections. What decision rule is appropriate? The curves in Figure 4.5 show that only a small shift of weights in that direction raise the requirements to a 2/3 vote for a group of size 12. Thus, to preserve certain features of fairness, justice, and desirable actions, decision rules may be adjusted accordingly. Conversely, by considering a specific decision rule one can

TABLE 4.3. PROBABILITY THAT A GIVEN VOTER WILL LOSE ON ANY GIVEN VOTE, IN THE LONG RUN (Adapted from Rae, 1969)

n = size of voting unit
k = decision rule

	n = 3	4	5	6	7	8	9	10	11	12
k = 1	.43	.47	.48	.49	.50	.50	.50	.50	.50	.50
2	.28*	.34	.39	.43	.46	.47	.48	.49	.50	.50
3	.43	.34*	.32*	.35	.39	.38	.45	.47	.48	.48
4		.47	.39	.35*	.34*	.36	.39	.42	.44	.46
5			.48	.43	.39	.36*	.36*	.38	.40	.42
6				.49	.46	.38	.39	.38*	.38*	.39
7					.50	.47	.45	.42	.40	.39*
8						.50	.48	.47	.44	.42
9							.50	.49	.48	.46
10								.50	.50	.48
11									.50	.50
12										.50

* Probability associated with decision rule, k = majority rule.



NOTE: Probabilities may not be comparable between curves I and II. Curve II was not a part of Rae's analysis, instead it was calculated separately and added to this graph for comparison.

Figure 4.5. Probability That a Given Individual Will Lose on Any Given Vote, in the Long Run (Adapted from Rae, 1969)

begin to investigate who gets affected and in what ways. In this spirit, Schofield [1972] extends Rae's analysis to include larger populations, nonhomogeneous groups, probabilistic concepts, and other complicating factors. Among other findings, Schofield shows that majority rule is not necessarily the "ethical" rule in all situations [p. 207], and he provides a mathematical technique for making this assessment.

Theory of games. This approach to collective action stems directly from *The Theory of Games and Economic Behavior* by John von Neumann and Oskar Morgenstern [1947]. Their work was not a response to the aggregation problem raised by Black [1958] and Arrow [1951], although by itself it still represents one of the most outstanding achievements of this century [Rapoport, 1959]. In fact, the theory of games has grown to the point that it must now be considered on its own a major area of scientific investigation with a vast supporting literature. For this reason, only the relevance of game theoretic concepts to the planning arena can be discussed here. A general introduction to the literature can be found in Luce and Raiffa [1957], Rapoport [1959, 1966, 1970a, 1970b], and Shubik [1964]; Buchanan and Tullock [1962] and Riker [1962] apply game theoretic concepts to the analysis of political systems; and Bartos [1967] considers group behavior from this same perspective.

Game theory can be thought of as a science of rational conflict. It applies to those situations where two or more individuals have interests that are not coincident. Moreover, each individual is in control of different sets of choices and endeavors to select those that will

permit him to emerge with an advantage. The theory, using a foundation of very precise mathematical reasoning, describes the logic of such choices and prescribes what selections a rational player should make.

Game theory divides into two fundamental categories, 2-person and n-person. There are important differences between them, since by adding a third (or more) players the possibility of collusion and coalition behavior becomes a major consideration. Many insights useful to our analysis can be provided by 2-person theory (see Rapoport, 1966), however those concepts unique to n-person theory have more immediate bearing on the present discussion. Thus, focusing now on n-person concepts, games can be further classified as (1) constant-sum vs non-constant-sum, and (2) cooperative vs noncooperative. The former case concerns whether, in the game, one person's gain must be another's loss; the latter describes the degree of cooperative effort permitted or whether bargaining and coalition behavior will be permitted in the analysis. From these extensions the true value of game theory emerges, in that, by formalizing the nature of *cooperative* effort in conflict situations we move from an initial analysis of "conflict" by itself to include the process of "conflict resolution." Comparing this to the type of conflict prescribed for the conceptual arena (pp. 156-160), emphasizes the importance and power of game theoretic concepts within the collective action approach.

Within these basic classifications, game theory addresses conflict and strategy at three levels of resolution. Analogies can be found, for example, in theories of fluid flow where the basic unit of analysis might be (1) two particles interacting, (2) multiple particles

interacting, (3) an elemental volume of water, or (4) massive flow phenomena. Corresponding to these, game theory may be expressed in:

- (1) *Extensive form*, which fully describes the rules of the game and the step-by-step moves which each player can take. Each game is described by a game tree and can easily multiply into an immense number of strategies as the number of players and moves increases;
- (2) *Normal form*, which ignores the step-by-step possibilities and describes the game only in terms of the final payoffs available to each player under each combination of strategies. Information is presented in matrix form which permits an analysis of the logic of strategy choices; and
- (3) *Characteristic function form*, which ignores individual strategy choices and moves to the logic of coalition behavior. Each game is described by the payoffs available to all coalitions considered.

The problem is to determine both which coalitions form and how payoffs are distributed among coalition members. Usually, the assumptions adopted are that side payments (bribes) can be freely made and players can bargain over the division of payoffs. Thus, of primary importance to this study will be nonconstant sum, cooperative n-person theory, in characteristic function form, since this mode corresponds closely to the activities envisioned for the conceptual arena.

Let there be a set N of n players, and let there be subsets of N called coalitions designated $S, T, \dots$. The *characteristic function* is a rule which assigns a value of the game to each subset of the n players. The value of each subset is usually defined as the value of a 2-person game which results if the subset in question acts as a single player and if the remaining players form a single counter coalition. Thus, the characteristic function must have at least the following properties:

$$(1) \quad v(\phi) = 0 \quad \text{value of the empty set equals zero,}$$

$$(2) \quad v(S \cup T) \geq v(S) + v(T).$$

Condition (2) is called *superadditivity* which shows that some players can gain more by working together than by going it alone.

Thus, the paradox emerges. As usually defined, the rational game player (this also includes "rational" actors in fields of study other than game theory) is guided by the utility of outcomes to himself and to himself alone. But, under conditions of bribery and collusion it often happens that an individual can achieve more by joint cooperative effort with others, contrary to his best individual strategy.

So, let any disbursement of payoffs among the n players be described by the *payoff vector*,

$$(3) \quad \underline{x} = (x_1, x_2, \dots, x_n)$$

also,

$$(4) \quad x_i \geq v(i) \quad i = 1, 2, \dots, n.$$

Thus, under *individual rationality* each player would expect a payoff under collusion to be at least as big as the value of the game to himself working alone; furthermore,

$$(5) \quad v(S) \leq \sum_{i \in S} x_i \quad \text{for all } S \subset N.$$

Under *group rationality* no subset of players should get less than they could by joining a coalition; and finally,

$$(6) \quad \sum_{i=1}^n x_i = v(N).$$

A payoff vector which satisfies conditions (4) and (6) is called an *imputation*. One which satisfies (4), (5) and (6) defines

the *core* of the game, that is, an imputation which conforms to both individual and group rationality. Thus, given all possible payoff vectors, conditions (4) and (5) served to narrow down the number of allowable imputations according to these criteria showing how the pay-offs should be disbursed.

This is an essential feature of n-person theory, especially to this discussion. First, considering all possible coalitions that could occur among n players one might have to deal with $(2^n)-1$ different alliances. It would be necessary to (1) decide which coalitions are likely to form and (2) what distribution of payoffs is somehow *fair* and *appropriate* within the game context. Thus, the main thrust of n-person theory, at this level of analysis, is to find those acceptable constraints to be put on imputations, which *narrow down* the set of admissible coalitions. In addition to the core, which by conditions (4), (5) and (6) permits very few alliances, there are other methods for reducing the number of coalitions that should be considered; namely, domination in the von Neumann and Morganstern concept of solution, the Shapley value, the bargaining set, the kernel, the Ψ -rule, the Harsanyi bargaining model, and others [Rapoport, 1970b].

Again, the point to be made is that each of the above techniques for coalition restriction (decision rule?) emphasizes a different feature of the game and thus generates its own bias in the distribution of payoffs. For example, one may divide rewards equally, another may emphasize power and bargaining positions, and so on. This, in the end, still leaves the ethical question unanswered and may, strangely enough, be the strong point of game theoretic analyses. Rapoport

[1959] has stated that the power of this theory lies not in its successes but in its failures. He means by this that the logic, which is pure and almost irrefutable, can be pushed only so far until contradictions and paradoxes emerge in a very disquieting way. N-person solutions and especially *unique* n-person solutions are nearly impossible to come by. Yet, the theory when pushed to these limits reveals compellingly where additional factors and considerations must be brought into the analysis. By using this mathematical, axiomatic approach one's analysis will proceed to an impasse where extra game considerations must be introduced, usually in two ways:

- (1) By considering the process of conflict resolution over time; and
- (2) By introducing sociological and psychological features of the gaming situation which describe the people, their interactions, and their external contexts.

In this way, according to Rapoport [1970a, p. 41] "The chief value of game theoretic analysis is that it points to questions beyond its scope." Moreover, it relates logically precise concepts to conflict resolution that previously had only intuitive meaning. Thus, the *structure* which this analysis can provide becomes its dominant contribution to the conceptual arena and its operations.

Measurement of power. The Shapley value was introduced above as an approach to narrowing down the $(2^n)-1$ possible coalitions in an n-person game. In fact, this technique produces a unique distribution of payoffs emphasizing the value that players can bring to a coalition by joining that coalition. Although the original formulation [Shapley, 1953] was developed to measure the value of a game to a player, it has also been used as a normative index of a player's power in conflict

situations [Shapley and Shubik, 1954; Riker, 1959; Lucas, 1973],

where

$$\phi_i = \sum_{S \subseteq N} \frac{(S-1)!(n-S)!}{n!} [v(S) - v(S - \{i\})]$$

ϕ_i = Shapley value for player i

S = number of members of coalition S

n = number of players

$v(S) - v(S - \{i\})$ = incremental value which player i brings to coalition S.

Using this as a measure of power can be justified in those situations where payoffs, initially as a lump sum, can be divided up in any number of ways. However, the situation often arises in which a proposed action is simply adopted or rejected, one which has a *fixed* distribution of consequences for all; no redivision of spoils is possible. Under this circumstance, the Shapley value *as an index of power* is invalid [Coleman, 1978]. Further complications arise, in power measurements, because the Shapley index counts more than once those identical coalitions in which player i exerts a determining influence. That is, group 1-2-3-i would be viewed as different from group 3-2-1-i when using Shapley to evaluate the power of coalitions to act.

Coleman [1968] addresses this deficiency, which likewise poses a problem for the conceptual arena, and redefines the notion of power in those situations where a collectivity must adopt or reject a course of action that has a *fixed* profile of consequences for its members. Here, the question is not so much the power of members over each other, but (1) the power of the group to act, (2) the power of a member to

prevent action by the collectivity, and (3) the power of a member to initiate action by the collectivity. Thus, power is primarily exerted on the collectivity not so much on and among separate numbers (see p. 172). As an example, which may be useful in Chapters V and VI, Coleman reformulated the Shapley index for voting bodies considering the three additional conceptions of power,

$$(1) \quad A(N,m) = \frac{\sum_{k=m}^n \frac{n!}{k!(n-k)!}}{2^n}$$

where, $A(N,m)$ = power of the collectivity as a whole to act

n = size of the collectivity

m = number required to initiate or prevent action.

$$(2) \quad P_i(n,m) = \frac{1}{(n) \sum_{k=m}^n \frac{(m-1)!(n-m)!}{k!(n-k)!}}$$

where, $P_i(n,m)$ = power of individual i to prevent action.

$$(3) \quad I_i(n,m) = \frac{1}{(n) \sum_{k=0}^{m-1} \frac{(m-1)!(n-m)!}{k!(n-k)!}}$$

where, $I_i(n,m)$ = power of individual i to initiate action.

Vote trading and logrolling. This entire section on normative models began with the voting paradox of Black [1958] and the Impossibility Theorem of Arrow [1951], which exposed the inherent difficulties in aggregating individual preferences into social choices. Each successive model dealt with this problem in a slightly different way but usually, except for certain game theoretic concepts, ignored interpersonal interaction and mutual adjustments as a mechanism for bringing

forth a single agreeable course of action. The current class of models and others to follow directly introduce bargaining and coalition formation which incorporate a broader range of behavioral and sociological factors than previous models.

The collective action models described in this section presuppose that individuals have intense preferences for some issues and less intense interest in others. Given that the collective unit must settle on some combination of issues, each individual will trade his support for issues which concern him little in return for support on those issues with high salience for himself. One requirement here, which is particularly disturbing for the conceptual arena, specifies that issues must be separable and independent. Thus, one should have the opportunity to trade off his support for, say, education in return for support on an independent issue like defense. Unfortunately, the conceptual arena is water-related and somewhat issue-specific. It would be difficult to trade support for irrigation in return for support on flood control since in many cases one implies the other. However, there are enough independent features within the water management problem to encourage the introduction of vote-trading models. In addition, these personal interaction approaches provide a mechanism for incorporating preference *intensities*, which could not be introduced in voting schemes or spatial models. Preference intensities, although arousing the sticky problem of interpersonal utility comparisons, seem to be a key element in social choice processes.

Several approaches to vote-trading and logrolling are now available including the ground-breaking work of James S. Coleman [1966a,

1966c] and others [Wilson, 1969; Tullock, 1967, 1970; Bernholz, 1973]. The review here will feature the approach developed by Edwin T. Haefele [1970a, 1970b, 1971a, 1971b, 1972], because it is somewhat more operational than the others, and it has already been used to "politicize" an environmental planning model [1971c]. Rather than describing his basic theory, a simple example will reveal the flavor of his approach. Start with an initial agenda and voting matrix of 3 issues and 5 voting groups, operating under majority rule. The notation Y_2 , for example, means a group votes "yes" and the issue is 2nd in his salience ordering:

ISSUES	AFFECTED GROUPS					FATE OF ISSUE
	1	2	3	4	5	
A. Preserve lowlands	Y_1	Y_1	N_2	N_1	Y_3	PASS
B. Limit growth	Y_2	Y_3	N_1	N_3	N_2	FAIL
C. Develop uplands	N_3	Y_2	Y_3	Y_2	N_1	PASS

Their initial positions would pass A and C but reject B.

The next question should be, if trading is permitted, is this arrangement stable? Are there other arrangements which would permit voters to realize a higher number of their more salient issues? To investigate this, a preference matrix can be generated using the following notation:

-1 = membership in a winning coalition but a willingness to trade this winning vote for support on another issue on which he is losing.

0 = if winning on issue, an unwillingness to trade; or if losing on an issue, an unwillingness to give up any other issue to gain this one.

+1 = membership in losing coalition and a willingness to trade another issue on which he is winning he to gain support of this issue.

With these definitions the following preference matrix can be generated. Although enough data are included here to permit this operation, the original references should be consulted to help reduce confusion which may arise from this abbreviated example.

ISSUES	AFFECTED GROUPS				
	1	2	3	4	5
A	0	0	+1	+1	-1
B	0	0	0	-1	-1
C	0	0	-1	-1	+1

Possible traders are revealed by locating trading (column) vectors with at least one -1 and one +1; here, groups 3, 4, and 5 are anxious traders, but they each have to find a trading partner. By matching -1 with +1 in horizontal rows, two possible trading matches are identified: first, groups 3 and 5 will change votes on issues A and C; and second, groups 4 and 5 likewise will switch votes on issues A and C. No other trades are possible. Let, 4 and 5 trade first since each is trying to achieve their No. 1 issue (group 3 already wins on his first choice). Thus, by permitting trades a new voting matrix appears. Circles identify changed votes:

ISSUES	AFFECTED GROUPS					FATE OF ISSUE
	1	2	3	4	5	
A	Y_1	Y_1	N_2	N_1	N_3	FAIL
B	Y_2	Y_3	N_1	N_3	N_2	FAIL
C	N_3	Y_2	Y_3	N_2	N_1	FAIL

This process can continue until a stable voting matrix appears or until an indefinite cycling can be identified. In this way, the potential for striking a good deal is enhanced and, if cycling appears, one is notified that outside factors may need to be introduced to stabilize cycling.

Coalition behavior. To the extent that a political situation can be described by the existence of an authoritative allocation of positive and negative effects, to this extent the overarching problem of concern so far can be called a political problem. In most political situations the main avenue of goal attainment is through coalition formation [Leiserson, 1966]. Riker [1962] even equates the study of politics with the study of coalitions. Less sweepingly, Shapiro [1971, p. 107] has stated that, "No model of public investment is complete without introducing the effects of the interaction between pressure groups and agency officials." Thus, group interaction and coalition behavior represent a substantial consideration in the collective action approach.

All of the models in this normative section have a distinctly quantitative flavor, and this was the primary intent of this survey. However, a paragraph on normative coalition models could not be complete without at least brief mention of an important work in narrative form. Investigators represented in this thesis attempt to answer two main questions, (1) *which* coalitions form, that is, *who* joins, and (2) *how* rewards are distributed among coalition members. Another question either omitted or axiomized, and of equal importance, is *why* individuals join groups. It involves more than just a human propensity to join groups, as some authors have suggested. In his contemporary classic work, *The Logic of Collective Action*, Mancur Olson [1965] lays down the foundation for describing why individuals join groups of various sizes, purposes, and descriptions. As a normative statement, Olsen's conceptualizations are presumed to explain the *why*, as models to be reviewed describe the *who* and *how*.

The previous section on game theory introduced the concept of cooperation and collusion within the context of mixed-motive, n-person games, in which both conflict and common interest are present. One drawback, though, resides in the fact that the characteristic function, the structure of payoffs, *alone* determines the nature of expected alliances. Other extra-game factors like personality, attitudes, norms and mores, sociological constraints, etc., do not enter the analysis. Therefore, this section will introduce certain normative concepts of interpersonal interaction in coalition behavior, first to complement deficiencies in game theoretic perspectives, and second to provide models which will support analyses in Chapters V and VI.

In a *coalition situation* [Groennings *et al.*, 1970] there are three or more actors, whose preferences on the issues are not identical. Also, it is not the case where one outcome would produce maximum satisfaction for all actors. Moreover, there is incentive for cooperation, in that, by cooperating at least two actors can gain more than they would have by acting alone. Thus, the term *coalition* means two or more actors in a coalition situation who jointly use resources to determine the outcome of a decision [Gamson, 1964, 1968]. Hence, the decision is one in which no single actor can specify an outcome and bind all other actors to it [Kelly, 1970c].

Many of the recent studies of coalition formation have been conducted under experimental conditions by social psychologists. Their primary purposes have been to evaluate the assumptions and results of normative game theory or to use game theoretic constructs to formalize the empirical study of group behavior. Thus, a large portion of their findings are descriptive in content, not intended to be normative prescriptions of appropriate coalition behavior. However, several normative statements are now available based on the findings of experimental investigations. One such model has been developed by Leiserson [1966, 1970b] to cover several situations; (1) where potential coalition members share similar attitudinal and ideological perspectives, (2) where actors share no common ideological interests and are indifferent between possible winning associations, and (3) in-between situations. A flow diagram in Figure 4.6 prescribes the way in which coalitions evolve given that members do not encounter ideological conflict.

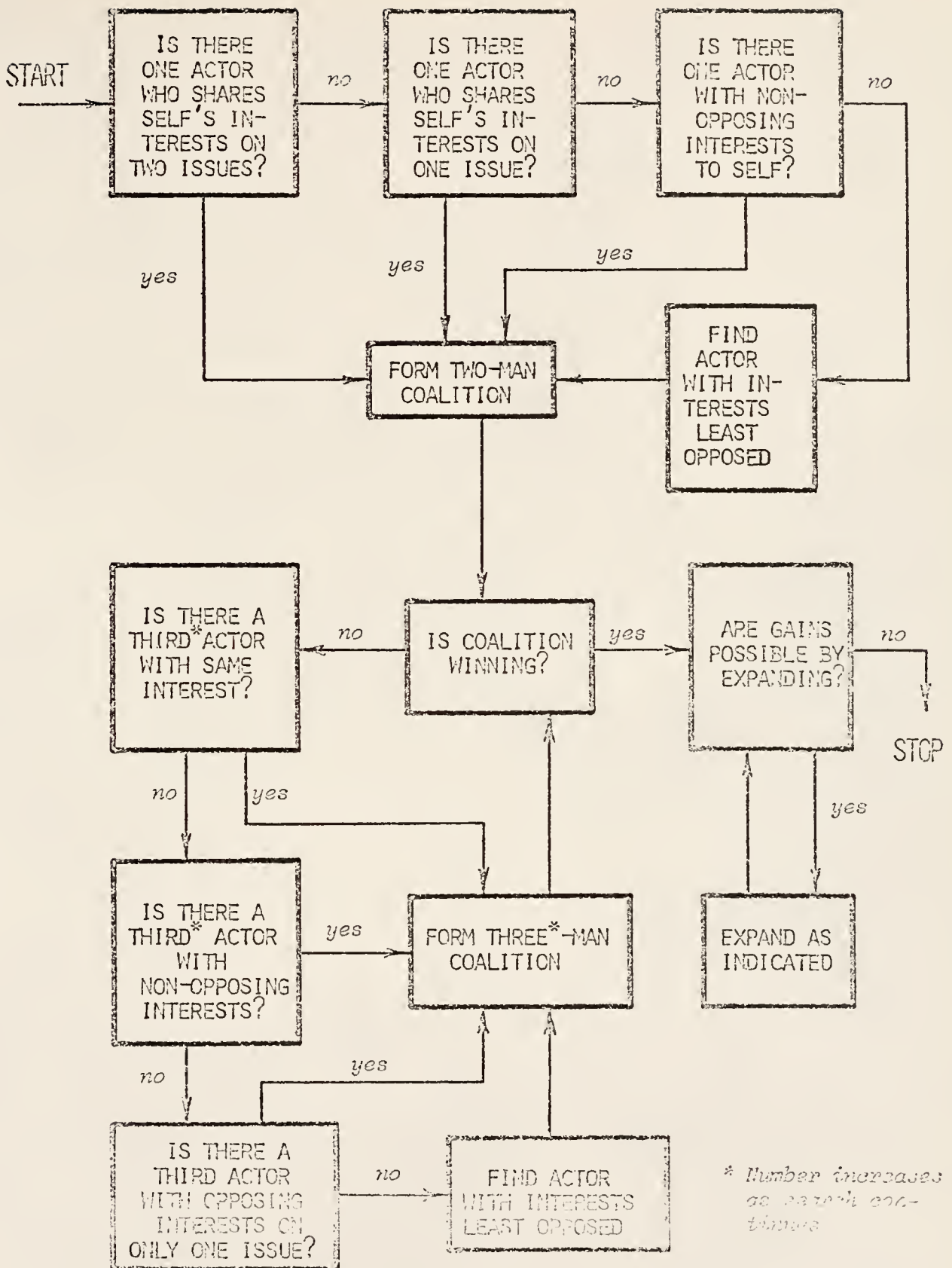


Figure 4.6. Model for Coalition Formation Where Potential Members Share Attitudinal and/or Ideological Positions (Adapted from Leiserson, 1966, 1970)

Other such schemes have been developed and tested for conditions (2) and (3) and can be adapted to real problems.

Answering the questions how and which alliances form still leaves the problem of dividing rewards among coalition members, given that consequences are divisible in this sense. Although most water programs generate a *fixed* profile of effects, there are still certain features, costs, e.g., which can be divided in various ways. Game theoretic approaches address the division of spoils from various perspective like the Shapley value, the bargaining set, the kernel, and others. Likewise, the efforts of experimental social psychology have produced certain prescriptions for division of payoffs based on observations of group behavior. Chertkoff [1970] considers a blending of two factors to determine the appropriate division; (1) people believe the division of rewards should reflect the amount of resources a member brings to the alliance (the parity norm), but (2) people also believe that rewards should be somewhat equalized since even the most powerful cannot be a winner without all members. Thus, the expected reward of member i should be,

$$E_i = \left(\frac{r_i}{S_r} P \right) \pm \alpha \left[\frac{P}{n} - \left(\frac{r_i}{S_r} P \right) \right]$$

where

P = total reward won by coalition

E_i = expected reward of member i

r_i = resources of member i

S_r = sum of resources in coalition

n = number of coalition members

α = coefficient to balance rewards

$$\pm \text{ should be } \begin{cases} + & \text{if } \left(\frac{r_i}{S_r} P \right) < \frac{P}{n} \\ - & \text{if } \left(\frac{r_i}{S_r} P \right) > \frac{P}{n} \end{cases} .$$

The balancing coefficient α determines the group feeling about the degree of emphasis to be placed on each factor. A value of $\alpha = \frac{1}{2}$ means that people expect their share to be halfway between the parity norm and the equal division norm. As an aside, a value of $\frac{1}{2}$ has often given good fit to experimental data.

Bargaining. Words like coalition formation, bargaining, and negotiation are often used interchangeably, including this thesis, but differences in meaning do exist. These distinctions will not be aroused here. Essentially, though, bargaining differs from the other categories of collective action above by focusing more heavily on time and the *process* of reaching agreements. According to Cross [1969] bargaining refers to the process of demand formation and revision providing the basic mechanism whereby parties converge toward an agreement, possibly through disagreement-demand-(threat)-concession-agreement. This focus on time has discouraged normative approaches thus leaving bargaining investigation to empirical studies which are best described in the section on behavioral models. As a brief comment, though, such empirical observations often result in suggestions for bargaining protocols and limited scenarios which have a normative flavoring [Kelly,

1968, 1970]. Studies of collective bargaining likewise yield analyses with strong normative implications usually through the manner in which they prescribe a structure for the process of bargaining. Two notable examples are *A Behavioral Theory of Labor Negotiations* [Walton and McKersie, 1965] and *Strategy and Collective Bargaining Negotiations* [Stevens, 1963].

One popular normative approach to the analysis of bargaining has been described in the section of game theory. Bishop [1963] provides an excellent review of these models which collectively suffer from a common disability. Game theoretic results usually reflect the structure of the game only and thus cannot include extra-game features like interpersonal relations, behavior and, more importantly, the process of bargaining over time. Again, numerous bargaining models exist which attempt to describe this process over time; they will be explored later. However, there are a class of normative models, in addition to game theory, which go one step further by including time as an important feature. As a class they have been loosely called "economic" models of bargaining. One such model begins with the standard Edgeworth Box (see, Henderson and Quandt, 1958) and the requirement for two competing actors to bargain over the desirable point on their contract curve, thus the division of two commodities between them [Wade and Curry, 1971; Curry and Wade, 1968]. An important ingredient here is the presumption that each player is impatient over time and wishes to reach an agreement. Furthermore, the analyst can describe each actor's *offer curve* which show their acceptable exchange ratios (of commodity i for commodity j) for each time step in the bargaining process. The pressure of time

forces each player to adjust his ratio, although possibly at different rates, until a bargain is agreed upon; that is, after a certain number of rounds each player agrees on the same exchange ratio, thus specifying a unique point on their contract curve. Following this type of analysis statements can be made as to the likelihood of agreement, when it will be reached, the terms of the trade, and so on.

John G. Cross [1965, 1967, 1969] has developed a more sophisticated model of bargaining still in this same economic category. As a simple case he considers two persons negotiating over the division of a fixed quantity M of a single good which is continuously divisible, i.e., $q_1 + q_2 = M$. Each player has a concession rate, r_i , which can vary over time, and they incur certain costs as each time period passes. Furthermore, as the bargaining process continues each person learns more about his opponent, and so their demands and concession rates change over time. Following a sophisticated development, including certain simplifications for the sake of operationality, Cross derives the size of player 1's share, q_1 , as a function of the time of agreement, $\bar{t}$.

$$q_1 = \frac{1}{2} \left(m - \frac{C_1}{af} + \frac{C_2}{ag} \right) + \frac{r'_1 - r'_2}{2a} \left[\frac{\frac{C_1}{af} + \frac{C_2}{ag} + M}{\frac{r'_1}{a} + \frac{r'_2}{a}} \right]^{\frac{1+A}{1-A}}$$

where,

q_1 = size of player 1's share

M = size of commodity to be divided

C_i = cost per bargaining round to player i

a = discount rate

f = marginal utility of q_1 to player 1.

g = marginal utility of q_2 to player 2

r'_i = expected concession rate of player i at $t=0$

A = slope of response function F for player 1.
 F is player 1's concession rate as a reaction
 to player 2's concessions.

The above equation was not simply written down *ad hoc* as it might seem without supporting information. Instead, Cross started with a set of reasonable axioms, assuming certain learning and discounting functions, and derived a series of equations using rigorous mathematical operations. Thus, the equation for q_1 in reality accompanies numerous expressions for variables of interest in the bargaining process, which permit the investigator to study the sensitivity of the system to changes in various factors, in addition to simply calculating outcomes. For example, after gathering data from past records or using experience from the conceptual arena, Cross' analysis would allow one to prescribe solutions which maximize each bargainer's utility considering the effects of cost over time, learning rates, willingness to make concessions, demands and counter demands, and so on. Furthermore, the analyst could identify those sensitive factors, like communication and learning rates, for example, which might contribute to the ability to strike a meaningful deal.

Models of Group Structure and Social Power. In the theory of games, and in other models, it is usually assumed that all players have complete information about each other and that communication is no problem. Assumptions like these, because they oversimplify, generally

lead to paradoxes and contradictions and ultimately the need to introduce extra-game factors. In this sense, the lack of behavioral or sociological content has been singled out as a pervasive disability of most normative approaches. For example, players do not have complete information; they cannot or will not form all possible coalitions because of personality, standards of behavior, existing group structure, power alliances and many other factors. One class of collective action models takes such factors into consideration often using graph theory and sociometric principles as basic building blocks. Since, these techniques are most commonly employed by social psychologists to study group behavior, they tend to have a descriptive flavor (sociometry and graph theory will be described in the section containing behavioral models). However, normative formulations do exist and thus contribute to the rounding out of this set of perspectives.

In his *Formal Theory of Social Power*, French [1956] provides a simple introduction to group decision making as a function of group structure and the power relations that exist; or in his words (1) the power relations among members, (2) the communication and interaction patterns, and (3) the relations among opinions. He employs five types, resources, or bases of power:

- (1) *attraction power*, the liking of one person for another,
- (2) *expert power*, the perception that one has superior knowledge and information,
- (3) *reward power*, the ability of one to grant advantages,
- (4) *coercive power*, the ability of one to grant disadvantages, and
- (5) *legitimate power*, the belief that another has legitimate right to prescribe behavior.

As a first approximation, the object of group interaction is collapsed into a single dimension, say, acres of marshland preserved. Each person has an initial position along this dimension corresponding to the area he wishes to be set aside. The model then presumes that social forces generate shifts in positions along the opinion scale for each cycle of interactions. Figure 4.7 contains a sketch which describes a simplified approach to this phenomena. Player A exerts influence over B which tends to shift B in A's direction. Forces from other players or B's resistance alone may tend to oppose A's effect. The strength of each player is shown to be linear and increasing in strength as the scale difference increases. Social interactions do not shift opinions completely in one step, instead, the model presumes a sequence of interaction cycles. At the end of each cycle, a player's position along the opinion scale reflects the equilibrium of forces on him within the social unit. At this time new discussions and interactions take place which permit another incremental shift in positions. The collective choice is thus described by the players' positions after an infinite number of cycles.

To illustrate this further French investigates the types of decision which might result from groups with different communication and power structures. The illustration in Figure 4.8 shows outcomes as a function of group structure for a collectivity of size 4 with initial positions $A=1$, $B=2$, $C=5$, $D=8$, along a scale of 0 to 10. Arrows represent the direction of player i 's power over player j . This information can be gathered using sociometric techniques and analyzed conveniently with the theory of directed graphs. Leaving out these details

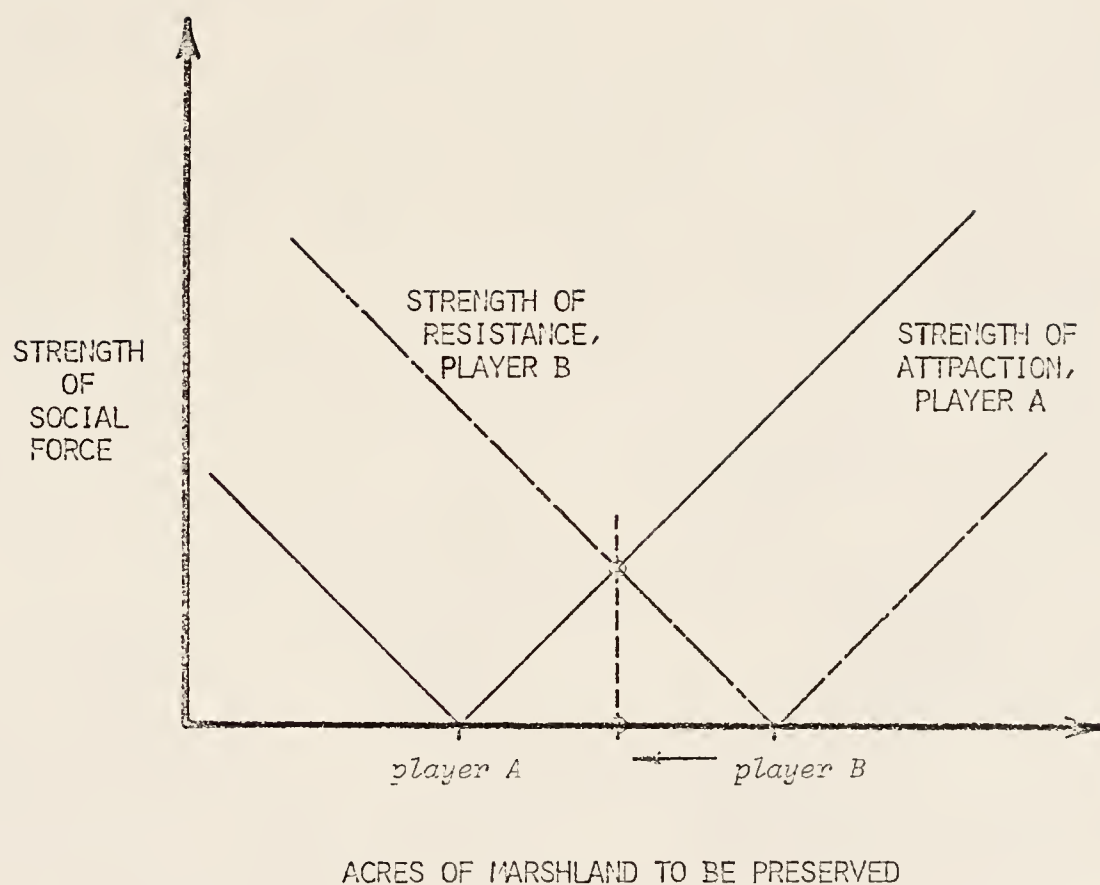
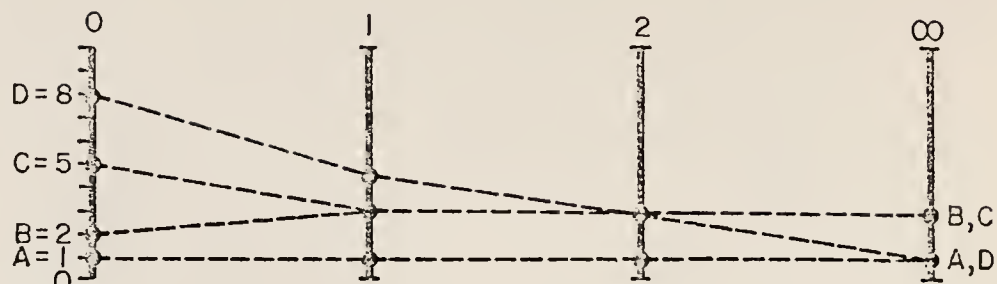
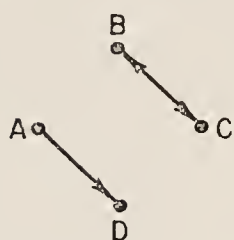


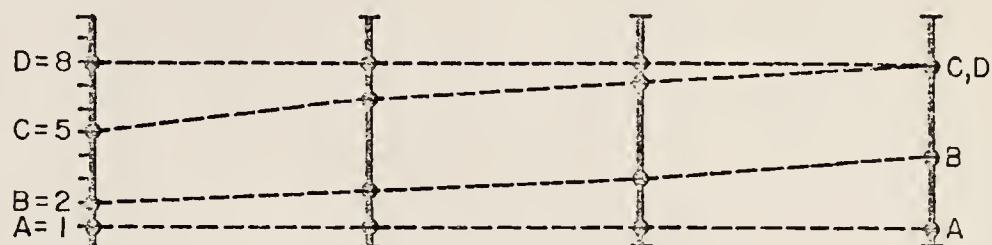
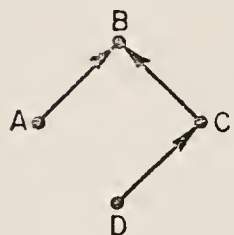
Figure 4.7. Effect of Social Power on Opinion Change
(Adapted from French, 1956)

CYCLE OF INTERACTION

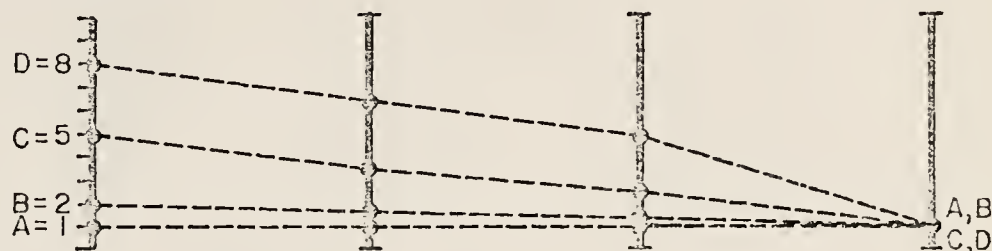
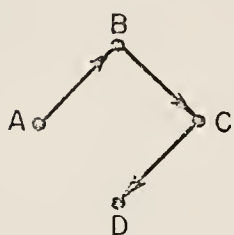
1. DISCONNECTED



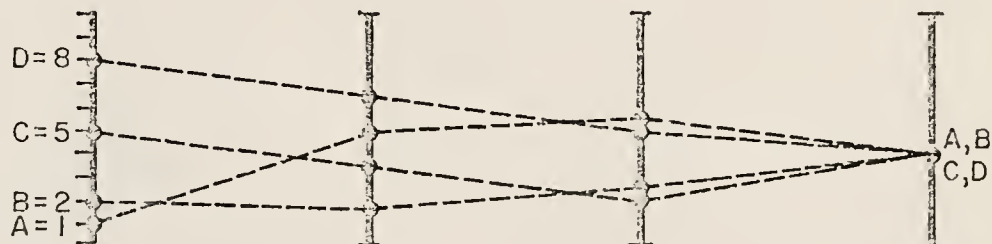
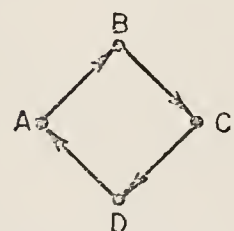
2. WEAKLY CONNECTED



3. UNILATERALLY CONNECTED



4. STRONGLY CONNECTED



5. COMPLETE

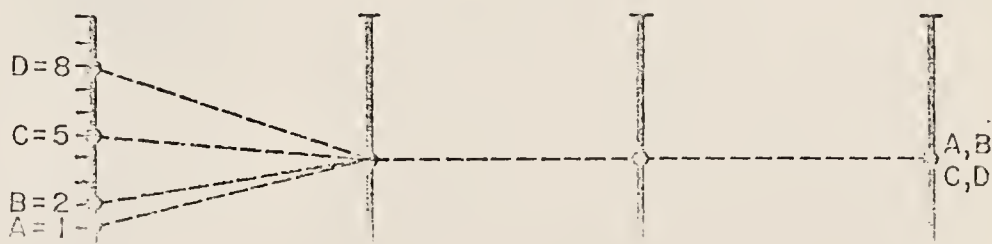
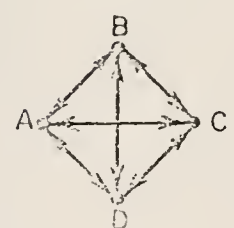


Figure 4.8. Effect of Group Structure on Social Choice Outcome
(Adapted from French, 1956)

for now, Figure 4.8 suggests that outcomes vary depending on the structure *within* the social unit even when players and their initial preferences are held constant. Moreover, it is not always possible, as one might expect, to generate a unique group solution. Thus, techniques like these would serve a valuable function when used to complement those models which do not include extra-game considerations. Although descriptive in flavor, the theorems from graph theory along with results from group studies can introduce a meaningful prescriptive content to such analyses.

A quick comparison can serve to illustrate this point. First, French arrived at his solutions using several basic postulates of power and opinion change; graph theory provided only a convenient way of organizing his variables in that article. But, what general results would have emerged had graph theoretic concepts served as the starting point? As an illustration, Rapoport and Horvath [1959] show that systems described by graphs containing cycles can exhibit forms of behavior which systems described by cycle-free graphs cannot. Referring to Figure 4.8, structures 1 and 2 have no cycles, where 3, 4, and 5 have identifiable cycles. Furthermore, their behavior are distinctly different due primarily to the existence of feedback capabilities in graphs with cycles. Thus, using graph theory alone, certain meaningful (and apparently verifiable) results can be deduced about systems with network-like characteristics. A more important result, however, is the fact that *structure within decision units exerts a powerful influence on group outcomes*. This suggests that decision techniques which ignore

the nature of networks inside the collective action body should be employed with care and qualification.

Theories of Organizations. Earlier sections discussed the social cohesion and social structure that evolve during persistent and patterned interactions between two or more individuals, i.e., a social system. This can also be called social organization. However, the subject of models which fall into this paragraph are more appropriately classified as *formal* organizations. If there exist *procedures* for mobilizing and coordinating the efforts of members, then a formal organization exists [Blau, 1968]. Hence, an (formal) organization is a system of consciously coordinated activities of two or more persons which has been explicitly created to achieve specific ends [Downs, 1965]. Moreover, it represents the highest level of generalization for decision-making arrangements in the context of this research, that is, individual to group to organization. In this way, theories of organizations complete the span of decision-making interest within a behavioral approach to water resource management. Attention must be called to Figure 2.11 (p. 69) which contains a representation of the water decision hierarchy cast within two of Parsons' functional subsystems. Blau [1968] shows that Parsons' subsystems are totally compatible with theories of organizations and in fact represent and contain cross-cutting organizations. Thus, if Figure 2.11 can be taken as an appropriate representation of an essential feature of the water resource decision system, then at the highest level of resolution the management problem becomes one of organizations.

For many years, individual decision making has been a focal point for intense study; this was mentioned earlier and a general introduction to the literature provided. Moving to the next level of resolution, collective decision making also has been a source of study for many years. Results from these efforts are spread more thinly in the literature, and as a consequence, a central cohesive theme becomes more difficult to locate, unlike individual approaches. Collective decision making is the dominant theme in this research and thus can be viewed as a *mid-range* decisional perspective.

Moving up the ladder of resolution, theories of organizations are next in line containing both individuals and groups in some type of interlocking system. It would be difficult to identify one level as more important than another, thus, as a first approximation, each level can be considered equally important. From Figure 2.11, the organization is the largest distinguishable entity in the "open" water management system, and it exerts controlling influences down to the individual. Thus, theories of organizations must be consulted before an analysis of water management problems can be proclaimed to be complete. Contained within this higher level analysis would be the conceptual arena and all features of the collective action approach discussed in this chapter. Outside the organization and above it would be those critical forces and factors which flow into the water management system but are not an integral part of it, for example, policies from higher governmental levels, influences from sectors other than water management, effects from other geographical regions, and so on.

Several notable attempts have been made to apply theories of organizations to the water management problem at this level of analysis. Ostrom [1971a, 1972a, 1973] has completely reevaluated theories of bureaucracies and public administration from this organizational perspective and concludes that a network of disjointed overlapping jurisdictions would serve the water management problem better than our present system of near-fully integrated bureaucracies. (Again this analysis includes or rather subsumes the conceptual arena; the arena does not stand apart.) In another study, Fox [1971c] and more specifically Ranney [1972] report on their analysis of water pollution control problems in Wisconsin. Ranney actually uses current principles from the theories of organizations to propose a specific design for water quality organizations in that state. His effort represents one of the very few attempts to design public water agencies using theoretical principles in this fashion. Most arrangements among water agencies either evolve in a piecemeal fashion or are established on a somewhat arbitrary or *ad hoc* basis. Thus, theories of organizations must play a vital role in future attempts to come to grips with the water management problem. They could very well represent the immediate guiding framework for most of the concepts discussed in this chapter.

As in the previous case of "conflict" and "power" there is not enough space to cover sufficiently the area of organizations. Instead, its position relative to other collective action approaches was described; the following list of references is intended to encourage further search and to serve as an entry into the appropriate literature [Simon, 1957a; March and Simon, 1958; Haire, 1959; Argyris, 1960;

Etzioni, 1961, 1964; Blau, 1962, 1968; Cooper *et al.*, 1964; March, 1965; Downs, 1966, 1967; Thompson, 1966; Carzo and Yanouzas, 1967; Lawrence and Lorsch, 1967; Dror, 1968, Miller, 1972].

Since the size of this report long ago exceeded a manageable length, a brief aside should not be out of line here. While it has not been apparent all along, the word "institutions" has purposefully been avoided in all sections. This is not the case in other water-related studies with a focus similar to this one. In those "institutions" becomes a catch-all term referring to water-related governmental apparatus and other social structures generally beyond the technical-economic realm. Much confusion has been generated by this careless usage, since in a great proportion of these studies, the term should be replaced by "organizations." This substitution would capture their intended purposes more precisely. Norman Wengert [1972a, 1972b, 1973] has studied this question in an attempt to sort out the confusion surrounding these terms. Following his recommendation, which is consistent with sociological interpretations [Eisenstadt, 1968; Knop, 1972], an institution can be defined as the *result* of a process, a process by which values are articulated, a process which has continuity over time, and a process which introduces persistent patterns into the activities of persons who did not necessarily participate in formulating the basic values. Under this definition, something like traditional water rights doctrines would be institutions, however, most entities loosely called institutions would not be.

Summary of Normative Models. It has been mentioned several times that the bipolar distinction between normative and behavioral

analyses becomes blurred very quickly. For one thing, in certain models the a priori normative prescription can be very conspicuous; in another large set of models, however, the unique prescription is deceptively masked, for example, in Cross' economic bargaining model. The dualism breaks down in a second case because normative prescriptions become, through research and knowledge advancement, more accurate descriptions of actual human decision behavior. At the limit, if one could prescribe in model form an exact a priori set of behavioral axioms, then normative and behavioral perspectives would merge.

This possibility has dangerous implications, in that *descriptions* of behavior tend to become *prescriptions* for behavior in an ethical sense [Argyris, 1972]. A leading edge of this phenomenon has already been observed. Over twenty-five years ago, Herbert A. Simon [1957a] popularized his now classic *description* of individual decision behavior in organizations, under the rubric "satisficing." He received much notoriety for formalizing this generally observed characteristic of organizational and administrative behavior. However, in recent years field studies of organizations, especially bureaucracies, have revealed that cases of bungling, ineptitude, and inefficiency have been rationalized, by the offenders, as examples of satisficing behavior. Thus, they had read Simon's book, and so, what had started as a description of behavior had turned into a prescription for behavior. After all, Simon did say that people in actuality "satisfice" rather than optimize. Then, why should people strive for any more?

This phenomenon adds a new dimension to the normative vs behavioral dualism. As long as our operational prescriptions for behavior

remain rudimentary, as they now are, the two poles will remain distinctly apart, and the ethical questions will likewise be more separated from the basic dualism. We should be prepared, though, for the inevitable improvement in our prescriptions, and thus, the inevitable intensification of the moral question. In this way, improvements in modeling must be accompanied by a parallel search for newer and more universal normative prescriptions for our milieu and what it should look like.

The preceding survey of normative models has shown that the state-of-the-art is substantially distant from an absolute blending of the two extremes. Many approaches, however, do reflect characteristics common to both extremes and in this way become difficult to classify. They were included in the foregoing section only if the specific prescription was identifiable and/or the intent was normative in character.

Models of Collective Action With Behavioral Tendencies

Normative models, in some controlling fashion, prespecify objectives, decision criteria, axioms for behavior, or other components of a decision situation. Results or decision outcomes from these models can thus be viewed as statements of how one *should* act or decide under various circumstances. In this way, by using a priori prescriptions, normative models carry with them substantial ethical or value-laden implications; hence, to some degree the value question has been answered or specified beforehand, either explicitly, or, more often, without substantial reflection.

The opposite is true of behavioral models. They seek not to prescribe desirable forms of decision behavior, but instead to observe actual real-world decision making, to describe these actions in models of some form, and to predict outcomes in future decision situations. Quite often, behavioral models take the form of narrative descriptions for this very reason. In recent years, though, an increasing number of investigators have applied a range of mathematical or statistical techniques to describe decision behavior which they observed or expected. Thus, models to be surveyed in this section can be viewed as attempts to fit a set of statements, either narrative or mathematical, to a real-world decision situation. Furthermore, the examples focus in common on those circumstances requiring collective action of some type; that is, no single individual can guarantee that the collective outcome will invariably conform to his personal preferences.

This feature deserves some additional comment. The dichotomy between individual and collective decision making is a fundamental and important one for many reasons. Considering only this survey of models, the significant factor is that many of the findings from theories of individual decision behavior serve as a foundation for theories of collective action. Thus, by focusing on collective choice, this survey assumes as common knowledge those principles of individual action which are indispensable to a fundamental understanding of collective models.

It is possible that this omission could lead to serious misunderstanding of the nature and role of models surveyed here. However, space limitations do not permit a proper accounting of supporting material from individualistic theories, since a preponderant fraction of decision

theory is devoted to an analysis of the individual actor in situations requiring unitary decisions. Because of this, significant references have been supplied at relevant points to serve as a guide to this body of knowledge. They have, for the most part, represented introductions to the normative literature; the references to follow focus on behavioral models of the individual type, and thus, compensate for this imbalance [Siegel, 1957; Coombs, 1964; Shelly and Bryan, 1964; Edwards, 1961; Starbuck, 1963, 1964; McWhinney, 1965; Becker and McClintock, 1967; Edwards and Tversky, 1967; Bauer and Gergen, 1968; Johnsen, 1968; Coombs *et al.*, 1970; Spier, 1971; Rapoport and Wallsten, 1972].

Normative models, almost by their basic nature, tend to be mathematical or quantitative and thus can be conveniently illustrated by formulas, graphs, and other concise statements. On the other hand, behavioral models tend to be comprised of narrative descriptions, procedures, scenarios, etc., which make them difficult to survey in a few short paragraphs. In such instances, the strategy will be to identify the approach, provide a brief description of its essential features, and include references to the appropriate literature.

Descriptive Political Models. Nearly all of the learned works in political science, produced subsequent to the normative efforts to design an American constitution, have been *descriptive* in nature; these subsequent investigators have primarily sought to explain or to describe how the political system works from a variety of theoretical perspectives. Only recently have serious attempts been made to reexamine systematically the original normative political logic to revitalize interest in the normative design of political apparatus [Dahl, 1956;

Ostrom, 1971b, 1972b, 1973]. Mathematical efforts with this same intent have been described earlier [Downs, 1957; Riker, 1962; Buchanan and Tullock, 1962; Davis *et al.*, 1970]. Similar attempts to reevaluate the organizational and institutional arrangements specifically surrounding water resources management have also been cited earlier in several places.

Policy-making process. From this vast body of descriptive political science literature, those descriptions of the, quote, policy-making process are the first to have specific bearing on the conceptual arena. Earlier sections introduced the notion of a policy choice vs design choice (p. 87) and briefly described in the policy process (p. 180). In short, these models of collective action describe the policy process as a passive, slowly moving sequence of actions which attempt to move away from "bads" rather than toward "goods." Hence, policy is formulated in a series of incremental steps reflecting the mutual adjustments among competing interests in the process. Information is very limited; time precludes the investigation of all but a few alternatives that come to mind; and means and ends are blurred and blended into a consolidated course of action.

This incremental characteristic of policy making has important implications for the proposed arena. Primary among these is the suggestion that no matter how grandiose are its potentials, no matter how broadly based are its decision rules, the *actual* arena process may still be that of "disjointed incrementalism," and potential outcomes will still reflect that reality; that is, they will move away from crises and not purposefully toward desired targets. It further suggests

that, like the 3rd law of thermodynamics which rules out 100 percent efficiency, it may not be possible to overcome that inertia or to get any more than "incrementalism" out of the social decision process no matter how sophisticated our methodologies may be.

Bauer and Gergen [1968] provide one of the best general surveys available into all forms of policy making; Ranney [1968] likewise should be consulted for a collection of basic informative articles. The fundamental expositions on disjointed incrementalism can be found in the works of Charles E. Lindblom [1955, 1959, 1965, 1968] and Braybrooke and Lindblom [1963]. Contrasted with these descriptions of policy making are the normative methodologies popularized by the Rand Corporation's development of systems analysis for the Defense Department in the early 1960s [Quade and Boucher, 1968]. Systems analysis of this variety, represents an attempt to systematize and integrate economic theory and other quantitative decision theories (mainly operations research) into a rational economic approach to public decision making. This same kind of normative model was later extended to the PPBS (planning-programming-budgeting system) adopted by *all* government agencies as their uniform evaluative technique [Lyden and Miller, 1968; U.S. Congress, 1969].

The most visible attempts to critique the troublesome conflict between these two perspectives on policy making have been provided by Yehezkel Dror [1967, 1968, 1971], Aaron Wildavsky [1966, 1967, 1970], James Schlesinger [1967], and Haveman and Margolis [1971]. Dror, in particular, provides a very compelling analysis of the strengths and inadequacies of the current normative and behavioral models of public decision making. His examination, by focusing on the same types of

decision models adhered to by Federal agencies engaged in water resource planning and management, contributes to a better understanding of the conceptual arena and the problems it may encounter. For example, without expanded methodologies, the arena would continue to suffer from the stiffling effects of incrementalism and the deficiencies of systems analysis and cost-effectiveness analysis (referring here to public decision contexts only). To correct for these problems, Dror has described not only a new approach to the types of questions addressed by the arena but also a new professional discipline schooled in its requirements. These recommendations will be outlined here not as a set of interesting observations, but instead, as proposed criteria to accompany and complement those formalizations of arena structure presented in pages 130-170. It is unfortunate that all supporting material for the arena cannot be presented in a single unified section; however, certain particular items take on a fuller meaning when included here in the context of their evolution.

The new professional discipline, somewhat ambiguously called "Policy Science," was first proposed by Harold Lasswell in 1951 [Lasswell, 1968]. Dror [1967, 1970] and Lasswell [1970] describe more fully the scope and objectives of policy sciences which Quade [1970] identifies as, "an interdisciplinary activity that attempts to blend the decision with the behavioral sciences" [p. 2]. Policy sciences, then, professes to fill the cracks between disciplines; it attempts to bridge the interface between qualitative and quantitative approaches to public decision making. Recalling the short review of policy making, from above, the policy scientist would be well versed in the "hard"

techniques from systems analysis, but would qualify their applications with an understanding of the "soft" features of social and behavioral science concepts so visible in the incrementalist approach. As might be expected, this new discipline has a professional journal, *Policy Sciences*, and academic curricula for training policy science operatives, described in the December 1970 and March 1971 issues of that journal.

The point to be made here is that the arena proposes to answer the same questions addressed by the policy sciences; that is, (1) overall plan or policy configurations not technical design details, (2) resolution of diverse value systems, (3) perpetuation of a managed or structured conflict, among many others. Along with their similar objectives, the arena proposes to use the same tools as the policy sciences, quantitative decision techniques along with the more qualitative contributions from social and behavioral sciences. In this way, the arena conforms to the state-of-the-art in policy and decision theories and is prepared to adjust itself as newer and more tested approaches become available.

The congruence between the arena and policy sciences also answers another very critical question posed in an earlier section; who will run the arena? This does not establish the legitimate, formal decision maker, nor does it require that the arena be physically located in any given place. It does, however, suggest in a most compelling way who the arena "manager" should be and what his background should contain. By prescribing arena leadership in this fashion both pure politician and the pure technical expert would be denied a dominant role in arena affairs. Instead, the manager would be one who,

as his profession, would maintain the arena's integrity, objectives, and activities consistent with original intentions. He would also, because of his professional background, have the skills required to maintain the interface between technical, administrative, and political affairs.

Community decision making. The introduction to this section on political models pointed out that nearly all political models of collective action have a descriptive (behavioral) perspective. Most broadly based political theories, though, are too general in scope to be included in this models survey; so, by moving down the scale of generality, models of the overall policy making process were the first to have immediate relevance for the conceptual arena. Moving again, to a level of more limited scope, political models of community decision making also contribute to a better understanding of the arena and its relationship to the social decision overlayer. In fact, considering all models surveyed both normative and behavioral, those classified in this category have the most immediate bearing on Chapters V and VI and the entire collective action approach.

Most water resource management activities penetrate and blend with local social decision processes, even those activities with substantial Federal involvement. In this way, water planning becomes almost synonymous with community decision making; and, the findings from community studies should likewise prove valuable to water-related activities. "Indeed, it is often helpful to see the planning process within a larger community decision-making perspective" [Mann, 1964, p. 59].

A *community* has never been satisfactorily defined, and so the scope of community studies labors under this disturbing ambiguity. For the models survey, these studies can be identified by their attention to local decision making, considering issues of direct consequence to members of the social unit in question. Federal and often regional decisions lie beyond the scope of community studies; likewise, corporate actions by independent groups within a given area lie inside the ebb and flow of local decision interactions.

Although earlier studies can be cited, contemporary interest in collective action, within this "community" frame of reference, blossomed after the publication of Floyd Hunter's *Community Power Structure* [1953]. He showed, based on field studies in Atlanta, that community decisions were controlled by a hard-core power elite. In contrast to this, Robert A. Dahl's study of New Haven, reported in *Who Governs?* [1961], showed that community decisions were pluralist in nature with power diffused over a range of crosscutting groups and interests. These two works represent the foci for two contrasting schools of thought, around which most of the vast contemporary literature can be grouped. Unfortunately for students of community decisions, this literature tends to concentrate on methodological disputes and deemphasizes substantive appraisals of possible fundamental laws governing community behavior. For this thesis and other work in water resource planning and decision making, this is not unfortunate. Fundamental laws are less crucial than methodology; it is more immediately useful to be able to identify actors, issues, power relationships, etc., and to measure their descriptive characteristics.

Thus, the existing literature on community studies has much to contribute to a collective action approach in water management.

Recalling the requirements from introductory sections of this chapter, both *substance* and *process* serve as points of interest to community studies. Outside of several works in the planning literature, this body of knowledge, thus, represents the most unified approach to the types of decisions most pertinent to resource planning. For example, Miller [1972] has examined the *power structure*, defined as the patterned distribution of power in a social unit. This includes a static representation of the actors, their power and position, the issues, and other factors which comprise the substance of local situations. Miller also studied the *decision-making process*, defined as the actual process of influence exercised over time; that is, the progress of issue resolution from inception to decision. Here, one recognizes the types of interactions which link actors from one phase of the process to the next.

Given this unified focus on substance and process, and given the contrasting theoretical perspectives, stratification (Hunter) vs pluralist (Dahl), specific techniques and models used by community analysts can be surveyed with more insight:

- (1) *Positional approach*. Using this technique, one presupposes that the power structure consists of those individuals who occupy traditional positions of power, community officials, bankers, lawyers, etc. Its appeal stems from its economy and simplicity; however, actual influential leaders may not at all occupy these social positions. Moreover, the positional approach tends to reveal a power elite whether one exists or not, and produces a static, snapshot analysis with little consideration of linkages over time.

- (2) *Reputational approach.* To correct for the mechanistic flavor of the positional approach, investigators have attempted to ferret out those influentials who may not occupy formal positions in the social structure. They accomplish this by first selecting a panel of "knowledgeable judges" from the local community. Each judge is then asked to identify those individuals with a reputation for power in community affairs. This technique is more costly and requires more skill than the previous method, but it yields a more reliable description of power structures than positional approaches. However, the tendency is for reputational surveys to reveal the existence of a structured elite simply because of its initial assumptions. Results also have a static, snapshot quality and depend on the reliability of "judges" who respond on the basis of their own perceptions and biases.
- (3) *Issue analysis approach.* Both the positional and reputational techniques produce static analyses and focus on actors, power roles, and the prevailing influence structure. In contrast to this, the issue analysis approach views the decision-making *process* as the focus of the exercise of power and adopts this as the object of analysis. Actors and their roles come into play only as they form a network of action in the flow and process of decision making. To make this analysis, investigators must immerse themselves in the study of a decision as it transpires; thus, the issue analysis approach requires time, skill, and financial resources. Moreover, since a power structure is not the basic unit of analysis, this technique tends to reveal a pluralist form of decision making with an ebb and flow of different influentials over time.

Lewis Froman in his *People and Politics* [1962, p. 3] stated that this type of community activity is concerned, in its broadest sense, with the distribution of advantages and disadvantages among people. To properly analyze this distributional phenomenon, Froman identifies two critical factors, the actors involved, and the type of decision-making process, i.e., structure and process. Community studies illustrated by the methodologies presented above, cover both of these factors, and thus represent a unified portrayal of the collective action with which planning is concerned. As an illustration of the way in which these concepts can be related to conceptual arena Table 4.4 contains a description of a typical community decision

TABLE 4.4. MODEL OF THE COMMUNITY DECISION-MAKING PROCESS
(Adapted from Nuttall *et al.*, 1968)

PROCESS STEP	ROLE
I. DEFINING OF PROPOSALS	
A. Discrepancy recognized between desired and existing conditions.	critic
B. Identification of problem as potentially actionable.	initiator
C. Formulation of alternatives "worth looking into."	planner
II. IDENTIFYING PROPERTIES OF ALTERNATIVES	
A. Inherent merits of alternative actions.	technical expert
B. Values held by individual actors.	investigator
C. Effect on individual actors and whole collectivity.	evaluator
D. Effect on position of actors in social structure.	evaluator
E. Availability of social support for alternative courses of action.	inside dopester
III. STRUCTURE OF SOCIAL FIELD	
A. Identification of potential support and opposition.	strategist
B. Communication of preferences and support.	advocate
C. Initial negotiations over exchange of positive and negative sanctions.	mediator
D. Specific alternatives for overt decision making.	planner
E. Strategy for overt decision making.	strategist
F. Organize personnel and resources. Transform proposals into issues.	organizer
IV. DECISION MAKING PROCESS (MAY BE REPEATED)	
A. Acknowledge overt commitment and responsibility.	spokesman
B. Involve relevant audiences.	propagandist
C. Exchange support and sanctions.	arbitrator
D. Final negotiation.	negotiator
E. Commit entire collectivity to agreed course of action.	facilitator
F. Legitimation.	formal authority
V. CARRY OUT CONSEQUENCES OF DECISION PROCESSES	
A. Implementation.	formal roles
B. Final application of positive and negative sanctions.	enforcer
C. Appraisal of actors and power relations.	evaluator
D. Appraisal of chosen action and its consequences.	analyst
E. Reappraisal of program.	critic
VI. BEGIN PROCESS AGAIN...	

process with a breakdown of process steps and power roles which might be associated with each step. This table can be viewed as a refinement of the social decision trajectory from Figure 2.12 (p. 75) and Rogers' collective action model from page 137. In general, this type of model reveals that there is more to planning than that which transpires within the planning office. Moreover, planning output must harmonize in one way or another with the overall trajectory of the decision process, thus the requirement for a *process* or *action* focus in planning behavior (p. x, 104). In line with this, models like the one in Table 4.4 identify the steps or phases the conceptual arena can expect to encounter as a particular water-related issue evolves from inception to implementation. Each phase may require different analytical techniques and include an ever-changing set of actors (roles). Thus, contributions from community decision studies can help to:

- (1) Identify the actors and roles to be represented in the arena;
- (2) Describe the linkages and power relations which exist in the local situation for this specific water-related issue; and
- (3) Track the evolution of the decision process to keep the arena in "synch" with the societal overlayer.

Much more needs to be explored here than space permits. Thus, as was the case with "conflict," "power," and "organizations," an introduction to the relevant literature is provided to encourage future attempts to introduce community decision findings into water management efforts. First, Pellegrin [1967] contains a bibliography of 310 titles, also Mann [1964], Polsby [1968], and P. Friedmann [1970] provide excellent reviews. Sizeable collections of relevant articles can

be found in Clark [1968], Hawley and Wirt [1968], and Bell *et al.* [1969]. Methodological issues are discussed in Fisher [1962], Polsby [1963], Sollie [1966], Rose [1967], Gergen [1968], and Ricci [1970]. More attention to models have been provided by Banfield [1961], Dahl [1961], Agger *et al.* [1964], Clark [1968], Nuttall *et al.* [1968], Rogers [1970], Gilbert [1972], and Kreps and Wenger [1973]. Methodologies developed by these investigators have been applied to a limited number of water-related problems, namely, the Susquehanna [Borton *et al.*, 1970], urban flood plain studies [Sheaffer *et al.*, 1970], and a series of rural water studies from Mississippi State University [Wilkinson, 1966; Wilkinson and Singh, 1970; Peterson, 1971; Peterson and Ross, 1971]. Dynes and Wenger [1971a, 1971b] have made limited applications of a model they developed, to water-related problems.

Models of Behavior in Groups. The previous section on descriptive political models identified certain models useful to an understanding of the conceptual arena at two levels of generality, the overall policy making process, then community decision making. Moving to a still smaller unit of analysis, models of group behavior also relate directly to those phenomena associated with the conceptual arena; however, they are less "political" in nature and thus occupy a section of their own. Models in this category are less appropriate for interest groups, pressure groups, or political models at a broader level of analyses. Instead, this section focuses on the contributions of small group research which defines a group as a number of persons each of whom can interact with or, at least, can take personal cognizance of each other [Homans, 1968]. Macro-behavior of the group as a whole

receives little attention, rather the interactions within the group become the main focus of attention. Hence, as the level of resolution increases from overall policy making to community decision to group research, the visibility and importance of human behavior and interpersonal interactions, in such models, correspondingly increases. To incorporate these behavioral factors into the collective action approach thus means to consider the findings of group research.

Nonmathematical models. Many findings from small group research are presented in narrative form often as hypotheses or propositions about expected behavior [Collins and Guetzkow, 1964; Shaw, 1971]. Investigators attempt primarily to describe the quality of group problem solving and decision making as a function of a wide range of external and internal conditions (or vice versa). Such findings, then, would have immediate application in the event that human participants were assembled in a workshop or arena setting for the purpose of exploring solutions to the water resource problem. The following hypotheses taken from Shaw [1971], and Table 4.5 from Collins and Guetzkow [1964] begin to describe the contribution to be made by group models and experts in group research:

- Hypothesis 1: The mere presence of others increases the motivational level of a performing individual (p. 82).
- Hypothesis 3: Groups usually produce more and better solutions to problems than do individuals working alone (p. 81).
- Hypothesis 7: Seating arrangement influences the quality of group interaction (p. 150).

Such propositions and the studies on which they are founded provide a wealth of information to assist the effort to construct

TABLE 4.5. SUMMARY OF CONDITIONS ASSOCIATED WITH SUCCESSFUL
CONFLICT RESOLUTION AND CONSENSUS
(Adapted from Collins and Guetzkow, 1964)

CONDITIONS ASSOCIATED WITH HIGH CONSENSUS IN GROUPS IN EITHER
SUBSTANTIVE OR AFFECTIVE CONFLICT

1. When there is little expression of personal, self-oriented needs.
2. When whatever self-needs are expressed tend to be satisfied during the course of the meeting.
3. When there is a generally pleasant atmosphere and the participants recognized the need for unified action.
4. When the group's problem-solving activity is understandable, orderly, and focused on one issue at a time.

CONDITIONS ASSOCIATED WITH HIGH CONSENSUS IN GROUPS IN SUBSTANTIVE
CONFLICT

(These conditions do not hold for groups in affective conflict.)

1. When facts are available and used.
2. When chairmen, through much solution proposing, aids the group in penetrating its agenda problems.
3. When the participants feel warm and friendly toward each other in a personal way.

CONDITIONS ASSOCIATED WITH HIGH CONSENSUS IN GROUPS IN AFFECTIVE
CONFLICT

(These conditions do not hold for groups in substantive conflict.)

1. When the group withdraws from its problem-solving activities by tackling only discrete, simpler agenda items.
2. When the participants withdraw from the problem situation and have little interest in what is being discussed.
3. When the participants withdraw from interpersonal contact with each other.

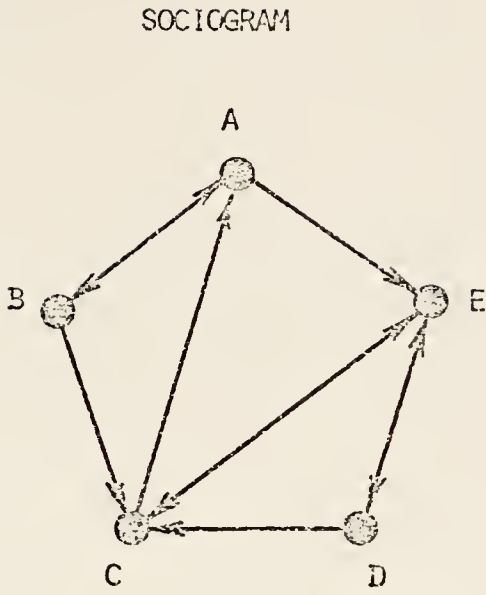
a problem-solving environment conducive to efficient and effective action. More specific models of group problem solving such as brainstorming, interaction management, delphi procedures, etc., fall naturally into this category also but will be described in a later section.

Mathematical models. Much of small group research seeks to discover fundamental patterns of human behavior in groups through the empirical observations primarily by social psychologists. Recently, however, there has emerged an interest in mathematical modeling of group behavior, for the same reasons that have established math modeling as a valuable exercise in natural sciences. Such models have their own contribution to make to the conceptual arena, especially in those circumstances where human participation is minimal and where a group-type input to the planning process is required. Since such group modeling can be considered to be relatively new, investigators have the good fortune to be able to draw upon important concepts developed in related fields. Predominant among these is the need to investigate both *structure* and *process* in group phenomena.

(a) *Group structure.* Investigations of group structure represent some of the earliest attempts to introduce a mathematical rigor into this qualitative field of study. Of primary interest was the need to identify the types of relationships which, for example, make one group of n members different from another group of the same size. Techniques of sociometry have been developed to satisfy this requirement. Usually, through interviewing or questionnaires a group member can identify those members he likes or dislikes, those he would like to work with or not, those he perceives to be holders of power, and so on.

Sociometric data of this type can be displayed and analyzed in *sociograms* similar to the one in Figure 4.9. Points or nodes represent group members, lines connecting nodes reveal whether or not a specified relationship, like *i* has power over *j*, exists or not. A moderate breakthrough occurred when it was realized that sociometric data, i.e., sociograms, could be completely transformed into a matrix format. The matrix *M* contains the same information as the companion sociogram: an entry of 1 in row *i* and column *j* means that the relationship of interest holds between *i* and *j*. In this form, sociograms can be subjected to an array of matrix operations to reveal such information as liaison persons, cliques, strengthening or weakening members, leaders, outcasts, etc. For example, M^2 and M^3 along with higher powers M^n identify the number of *n* links between members *i* and *j*. The entry 3 in row *b* and column *c* of matrix M^3 means that, according to the existing group structure, there are three ways of relating member *b* to member *c* by going through two other members.

These and more sophisticated matrix operations received substantial theoretical foundations with the development of the Theory of Directed Graphs. A *graph* consists of a set of points along with directed lines connecting pairs of points; a sociogram is an example. Graph theory, then, is a collection of theorems and operations used to explain or reveal the general properties of graphs or their matrix representations. A high level of mathematical sophistication has been reached by students of graph theory, and thus a valuable element of mathematical logic has been introduced into the analysis of group structure.



MATRIX, M

	A	B	C	D	E
A	0	1	0	0	1
B	1	0	1	0	0
C	1	0	0	0	1
D	0	0	1	0	1
E	0	0	1	1	0

MATRIX, M^2

	A	B	C	D	E
A	1	0	2	1	0
B	1	1	0	0	2
C	0	1	1	1	1
D	1	0	1	1	1
E	1	0	1	0	2

MATRIX, M^3

	A	B	C	D	E
A	2	1	1	0	4
B	1	1	3	2	1
C	2	0	3	1	2
D	1	1	2	1	3
E	1	1	2	2	2

Figure 4.9 Example Sociogram and Its Matrix Representations

The most immediate use of an analysis of group structure would be as a companion to the study of community power structure; in fact, sociometric analyses usually accompany such investigations. Once an appropriate set of actors have been identified, it is essential to establish further structural relationships, like who is perceived to have power by whom, who are seen as likely leaders, who will tend to work with (or form coalitions) with whom, and so on. Using techniques like those described above, systematic movement can be made toward an analysis of the structure which is an intimate component of any expected collective action surrounding water management.

An introduction to the literature on group structure and related group phenomena can be found in the journal *Sociometry* and in Forsythe and Katz [1946], Katz [1947], Chabot [1950], Beum and Brundage [1950], Festinger [1949], Spilerman [1966], Coleman [1964b], Carzo and Yanouzas [1967], Luce and Perry [1949], Glanzer and Glaser [1959, 1961], Labovitz [1967], Tichy [1973], Borgatta [1968]. The expansion of structural analysis to include graph theoretic techniques has been described by Harary *et al.* [1965], Flament [1963], Abelson [1967], Harary [1959], Coleman [1964c], Rosenberg [1968], Rapoport [1963].

(b) *Group process.* As in other fields of investigation, including the natural sciences, structure has been studied prior to and more extensively than process. However, investigators soon recognized that information describing structure alone could not provide satisfactory insight into group-related phenomena. Thus, in the late 1950s and early 1960s, mathematical models of group processes began to

surface in the social and behavioral science literature. These models ranged in scope from small intimate groups to larger social groupings considering, for example, voting behavior, social stratification, group mobility, etc. It would be difficult to select a single model for brief representation here, in the same way that it would be difficult to provide briefly a meaningful example of a typical hydrologic model. However, basic formulations often rely on the Poisson process and various stochastic models like the Markov process. One simple example used the Poisson process to describe the time sequence of voting in small groups. Another example employed a Markov process to represent the way in which group structure changes from time step to time step following periods of group interaction.

Excellent summaries of mathematical approaches to group and social behavior can be found in Coleman [1960, 1964c, 1973], Rapoport [1963], Abelson [1967], and Rosenberg [1968]. Bartos [1967], Coleman [1964d], and Simon [1957] provide descriptions of more specific models applied to group behavior. James S. Coleman in his monumental *Introduction to Mathematical Sociology* [1964b] establishes the foundation for a wide variety of mathematical applications to group and social processes. Compared to other studies in this area, his work nearly stands alone in terms of volume, mathematical sophistication, and application to real world situations. A glance at this book quickly reveals many ways in which such techniques would be useful to the conceptual arena.

Empirical studies. In general, the models of interest here resulted from the need to describe in a systematic way the findings of empirical group research. In contrast to this, models in the foregoing

section were usually formulated a priori then applied to or validated by empirical data. Many empirical studies either attempt to validate game theoretic propositions or employ the logic and structure of game theory as a guide to experimental work. McClintock and Messick [1966] provide an extensive bibliography of this empirical work.

(a) *Coalition formation.* Gamson [1964, 1968], Groennings *et al.* [1970], Leiserson [1966], and Kelly [1968] summarize the results of coalition studies and relate these to real-world applications. In particular, Gamson defines a coalition as the joint use of resources to determine the outcome of a decision in a mixed-motive (i.e., conflict and cooperation) situation involving more than two decision units [1964, p. 85]. Thus, "coalition" relates more to the use of influence in the decision making process than to any particular type of alliances within a group. This definition of a coalition situation (see also p. 203) describes as well the type of mixed-motive condition to be expected in the conceptual arena (p. 160); so, one would expect empirical studies to provide valuable sociological and behavioral input especially for normative models which usually restrict this real life perspective. One useful result is summarized below. A number of different theories purport to explain the norms and motives for coalition formation and the division of rewards. Empirical studies qualify these theories and describe the terms under which separate mechanisms are likely to be operative:

- (1) *Minimum resource theory*, is based on the parity norm which emphasizes the belief that a player should be rewarded in proportion to the resources he brings to the coalition. Empirical evidence supports this concept especially in stricter conflict and bargaining situations;

- (2) *Minimum power theory* prescribes that only coalitions should form which have minimum power but are still winning coalitions. Although this concept has utility for the normative analysis of collective action, there is little empirical evidence to support it;
- (3) *Anticompetitive theory* focuses on the potentially disruptive aspects of bargaining and assumes that players are very much concerned with maintaining smooth group relations. Strong empirical evidence exists to support anticompetitive behavior. Players often attempt to transform mixed-motive situations into those of pure coordination and to divide rewards more equally among all members. Thus, in real-life behavior there is a strong sense of "balance" [Taylor, 1970] or equity in face-to-face interactions particularly when the confrontations extend over a long run of more than one or two interactions. These results comprise the most serious qualification of current normative techniques for assessing the division of rewards; and
- (4) *Utter confusion theory* emphasizes a large number of chance factors, including the inertia of past decisions, which have nothing to do with power, resources, or other formally defined mechanisms. Surprising empirical support exists for this theory, which is understandable in light of the complexity and confusion associated with most coalition situations. Anyone who has experience with operational gaming would be a true believer in the pervasiveness of this observed mechanism.

(b) *Bargaining*. Much of the literature of bargaining has been introduced in the normative survey and in the foregoing section on coalition behavior. The primary difference here is that bargaining models try to account for the actions of each bargainer over time during the course of negotiations. Patchen [1970] and Kelly [1970a] summarize a number of different approaches to the study of interpersonal bargaining. Walton and McKersie [1965, 1966], Stevens [1963], and Flanders [1969] describe the process of collective bargaining. Lindblom [1955] describes the bargaining mechanism which predominates in public policy making; Holden [1966] extends this type of analysis to include the bargaining prevalent in pollution control decisions. But, of particular interest to this survey are the economic bargaining studies

reported by Siegel and Fouraker [1960] and Fouraker and Siegel [1963], and extended by Ofshe and Ofshe [1970]. One frequently seen model from these studies appears below as an expression of the bargaining behavior of player 1 in a two-player situation:

$$a_{i1} = \max E_1 - \left[\frac{\max E_1 - \min E_1}{1 + S_1 r_2} \right] \left[1 - \frac{1}{t_i r_1} \right]$$

where,

a_{i1} = level of aspiration of bargainer 1 at the time of the i th bid

$\max E_1$ = maximum payoff expectation of bargainer 1

$\min E_1$ = minimum payoff expectation of bargainer 1

r_i = rate of concession of bargainer j

S_j = index of bargainer j 's ability to perceive his opponents concession rate

t_i = duration of i th bargaining round.

Interactive Techniques and Simulations. Throughout this report the term "model" has assumed a variety of meanings. First, the thesis itself is a model of the water resource management system viewed as a "closed" system. In this general sense, *model* could be defined as an analogy to help visualize something that cannot be directly observed. Parsons' General Theory of Action formed the backbone of this analogy. Second, a closely related use would have *model* be defined as a logical set of analytic statements, or a set of laws. Much of this survey focused on models of collective action which were based on laws in one area (mathematical) assumed to represent laws in another (behavioral). A third use of the term *model* refers to the replication or reproduction

of something; simulation techniques and the math models of group behavior, those which have nothing to do with the logical structure of basic laws, serve as examples of this definition. A fourth definition, and probably not the last, views a *model* as a set of statements or guiding principles which describe, in this instance, how a decision could be made. Much of this thesis, including the models survey, have focused on definitions one, two, and three. This section includes definition four to balance out the exploration of collective action.

All along, as each model was introduced, an attempt was made to relate its potentials to the water resource decision problem and also to rank the model as "immediately important," "marginally useful," and so on. Thus far, the singular model with highest relevance were those in the area of community decision making. These would serve to organize the environment external to the conceptual arena. However, once the arena has been established, certain guiding principles or statements (i.e., models) will be required to shape the internal environment. Beginning on page 124 the set of "Criteria for Assessing Arena Performance" starts to satisfy this requirement. This section will continue in that spirit by reviewing a number of procedures which can be used to guide arena activities. Many of the data gathering and evaluation techniques from the behavioral sciences, for example, attitude measurement, preference scaling, etc., will be excluded from the review; however, their importance to the overall success of the collective action approach should not be underestimated because of this explicit omission.

Each model in both normative and behavioral sections has been explored in the context to Mode 4 (see pp. 135-141) which required active not passive collective involvement in planning activities. Moreover, it was recognized that full-blown involvement programs may not be in existence; as a result, in Mode 4 the conceptual arena may have to face a range of public involvement programs from none to fully developed. Partially for this reason, the following models have been divided into three categories: human-human, human-computer, and strictly computer. Such a breakdown does not suggest, though, that one should be employed at the exclusion of the other. They are intended to be complementary.

Human-human interaction. Models for this type of collective action would focus on first, the external environment, and second, internal arena affairs. Recent attempts to develop programs for workshops, public participation, advocacy planning, and ombudsmen attempt to bring individuals from the external environment into planning activities, but usually with little consideration of what would happen once they were inside. Such models will not be explored here in any detail, however, the following references provide a good introduction to the relevant literature. Advocacy has been described by Davidoff [1965], Peattie [1968], Freeman [1969], and Ross and Guskin [1971]; Sandler [1968] and Nelson and Price [1968] have reported on experiences with ombudsman programs.

Public participation programs have achieved only limited success in applications to date. Some view these results as an inadequacy inherent in the concept of "participation." This report considers these

disappointments to mean that we have not learned (we have not adopted the appropriate models) how to capitalize on the opportunities which involvement programs provide. An introduction to the theory, prospects, and experiences with public participation can be found in Verba [1967], Arnstein [1969], Bishop [1970], Borton *et al.* [1970], Bolle [1971], Warner [1971], Wengert [1971a, 1972c], and Dodge [1972].

To repeat from the previous paragraph, little consideration has been given to the types of interactions permitted *within* the planning process, once outsiders have been involved. In general, planners have simply listened to the positions of involved people without any systematic procedures to guide activities. To continue this way would not be compatible with the needs and the spirit of the collective action approach. More specific, programmed activities will be required to provide the needed data and feedback for overall planning.

One of the reasons for the conceptualized arena was to provide a setting for this type of systematic activity. Furthermore, a number of models presented thus far should serve as guides for programmed arena behavior: voting, vote trading, gaming, coalition formation and bargaining, small group activity, and many others. In this paragraph, though, models will be explored which are somewhat less formal but which still create an interactive environment to assist data gathering and the resolution of conflicting views.

These relate very closely to small group activities and range from brainstorming to interactive management to formal Delphi-like procedures. Delphi is of particular interest here because of its potential for resolving conflicting preferences. As originally

conceived, the Delphi method is a process for obtaining a measure of group wisdom by a controlled, iterative use of questionnaires and selective feedback of earlier group responses. It was originally intended to focus on value-free factual questions over which there is a divergence of expert knowledge. For example, Delphi has been widely used to extract from a group of experts the best collective predictions of alternative future conditions. In the environmental area, Delphi-like group sessions have been employed to obtain the best judgements over possible environmental effects from proposed water resource programs [Gemmell *et al.*, 1972; Dee *et al.*, 1972].

Introductory descriptions of the Delphi method can be found in Dalkey [1969], Dalkey *et al.* [1969, 1970, 1971], Brown *et al.* [1969], and Martino [1972]. These authors describe mainly the use of Delphi to explore *facts* without interjecting the diverse *value* positions of interacting participants. However, Rescher [1969] and Baier and Rescher [1969] show that Delphi can be used to explore situations involving conflicts of interest, like that to be found in the conceptual arena. It can be used to explain the structure of group values, to discover and sharpen the area of group consensus, to determine shared values and their relative weights, to reveal appropriate decision criteria, and so on. Thus, to relegate Delphi to an assessment of opinions about factual matters alone would be to lose its capacity to assist in the resolution of conflict. Several examples of the use of a so-called "policy" Delphi can be found in Schneider [1972], Turoff [1971], and Kane *et al.* [1972].

Human-computer interaction. If computers are available, Mode 4 can be supplemented by certain interactive computer techniques. The first type called operational gaming attempts to immerse participants in a realistic decision situation with the consequences of real decisions compressed, in time, by computer simulation. In most applications, citizens from the actual decision situation are assembled together and assigned various roles like politician, businessman, media representative, public-spirited citizen, etc. Within the context of a specific decision problem, say urban planning, the participants act out their respective roles as they might in the context of real-world affairs. After a specified time duration of discussion and bargaining, all actors are required to specify what their courses of action would be; for example, to support candidate X, to invest in a development project, to install pollution control devices, etc. This array of decisions is then submitted to computer simulation which calculates the consequences to be expected after, say, a hypothetical year has elapsed. Within minutes, the participants can see what the consequences of all their collective decisions would have been. Using this type of rapid computer-supplied feedback, interactions can continue for any desired number of cycles. In *Simulation and Society*, Raser [1969] explores the details of scientific gaming; Inbar and Stall [1972] provide a bibliography on gaming simulations and describe a number of specific games available. Several operational games have been developed for environmental problems, namely, APEX for air pollution situations and *The River Basin Model* which focuses on water pollution and its attendant economic, social, and political features [Environmetrics, Inc., 1971].

The second mode of human-computer interaction would be in the form of assistance for data gathering, group sessions, bargaining, etc. A number of techniques are available for rapidly processing the behavioral data which would be available in the arena setting. Hoinville [1971] describes a technique which requires participants to allocate a fixed amount of resource, say dollars, among different configurations of public policy. This exercise utilizes pictorial representations of different policy outcomes and determines, for example, how much pollution and risk of accident each different individual is willing to "tradeoff" for rapid highway access to points of interest. Tradeoff factors of this type are a key ingredient in all social choice situations.

Flack [1972] and Flack and Summers [1971] have described a computerized technique to assist conflict resolution in water resources management. Their proposal employs computer graphics for the visual display of various components of a water resource management situation. Each participant can express his preferences to the computer graphics system and obtain a display of effects on pertinent environmental parameters. Working in pairs or in small groups, the decision makers have the opportunity to adjust their conflicting preferences until the areas of common agreement become apparent. This mutual give-and-take, with the assistance of computer graphics, permits the unraveling of complex issues in a way that reveals common ground for cooperation and reduction of conflict.

Strictly computer simulation. The use of computer simulation alone restricts the breadth of planning operations available. In fact, all of the models reviewed, except those of human-human and human-

computer interaction, impose the same types of restrictions on planning behavior. *Strict mathematical or computer simulation cannot be used to generate or confirm hypotheses* [Kelley, 1968]. It can only tell us what will happen under certain initial conditions and pre-programmed hypotheses. Therefore, using human actors, which is a form of *nonprogrammed* input, will begin to move the sphere of planning concerns closer to the real world phenomena that are of primary concern to the collective action approach. Mode 4 was selected on this basis; the active participation of water-related actors is essential to extend the a priori programmed models which planners by themselves would have to rely upon. However, in the absence of established involvement programs, computer simulation will be the only means for introducing collective action phenomena explicitly into planning activities. In this sense, even though simulation suffers from the deficiencies mentioned above, it will be an indispensable tool for extending the existing mode of planning behavior, predominantly Mode 1 (see p. 134), into Mode 4.

As with other models, simulations can be divided into two groups, those which reproduce external arena conditions and those which focus on interactions within an established arena. In the first instance, collective action external to the arena can be examined in the form of formal general elections or as more informal coalition behavior surrounding water issues. Excellent reviews of election simulations can be found in *Simulation in the Study of Politics* [Coplin, 1968], *Computer Simulations of Voting Behavior* [Shaffer, 1972], and in a shorter article by Hayward Alker [1970]. Pool *et al.* [1965]

describe their model of the 1960 and 1964 presidential elections, while Abelson and Bernstein [1963] present their formulation more suited for local referenda and thus the matters considered in this thesis. Moving this type of analysis closer to water management Abt Associates, Inc. [1971] formulated a model which predicts the outcome of pollution referenda. Election simulations of this type can contribute to a better understanding of the forces in the social overlay which impinge onto planning behavior. However, our understanding derives not so much from the prediction of outcomes, but from the model's requirement to examine in detail a number of important factors currently overlooked by contemporary water planning practices.

Coalition behavior in the external environment, in addition to general elections, has also been the focus of simulation efforts; Coplin [1968] and Groennings *et al.* [1970] should be consulted for a review of several existing techniques. Two other approaches to coalition formation are of interest here. First, the dynamic interactions among participants in a water quality decision situation has been modeled and reported by Males *et al.* [1970, 1971] and Gates and Males [1970]. They used the techniques of industrial dynamics, developed by Forrester [1961], to weave the behavior of various agencies, business interests, and pressure groups into a representation of the social decision process. By incorporating different decision arrangements into the dynamic model, the authors were able to show how the quality of water management would vary from one organizational setup to another. They demonstrated, as well, the need to consider time-based feedback mechanisms in the analysis of complex socio-technical problems.

Bulkley and McLaughlin [1966] likewise consider the environment external to the arena. However, they emphasize the manner in which groups would form coalitions to affect decision outcomes rather than leaving the final questions up to a central board as did the previous model. In this way, the Bulkley and McLaughlin formulation touches more directly upon those properties of the local decision situation of interest to this thesis. However, this model does not consider the decision trajectory over time as does the Males and Gates approach, and thus suffers from the static disability. Cornblit [1972] takes an approach very similar to Bulkley and McLaughlin and extends the coalition process to include time-based changes. Both models, by coincidence, were developed for and applied to decisions in Latin America.

The two approaches just described for strictly computer simulations were meant to represent conditions external to the conceptual arena. Models for describing interactions to be expected within the arena have been explored in previous sections, especially in the paragraphs on coalition and group behavior. They need not be repeated here.

A Summary of Collective Action Models

The first task of anyone who undertakes a survey of models as extensive as that just finished is to establish a common basis for analysis and comparison. There must be some way to relate one item to another so that something is accomplished.

For a survey of collective action models this is a tall order. It is very difficult to identify any common threads or to reduce models

to simple common denominators. One reason for this is that models of collective action are in a sense higher order models, if one views individual action as a first-order consideration. As such, they are dominated by multiple interactions and feedback loops which assume a less prominent role in the, more or less, linear logic of individualistic approaches. True, individual decisions face complexities; but, these complexities lie within a unified goal consensus, hierarchy of command, and span of control that seldom exist in collective decision situations. Complicating the issue for this survey is the fact that the water resource decision problem includes a substantial behavioral component, which adds a nonprogrammed dimension to the analysis. Unlike a typical individual decision problem, which often can be understood by examining separately its constituent parts and then relating the parts to a unified whole, the behavioral collective decision problem can be addressed properly only by moving from larger, controlling perspectives downward to smaller and smaller components of interest. This reverses the flow of analytic thinking to which most of us are accustomed and complicates even the attempt to survey collective action models as a unique type.

Models of individual decision have been formulated and studied for many years, even many centuries if one traces back to the origins of the rational model for economic decisions. Thus, it can be safely stated that a reasonable measure of consensus exists about how such individualistic models should be classified. There also exists, because of the weight of such experience, a commonly understood set of abstractions which organize the essential features of individual

decisions, ranging from purely behavioral to purely mechanical decision circumstances.

Such is not the case for collective decisions, which Plato himself called the most difficult question of all science [Richerson and McEvoy, 1973, p. 123]. There does not exist a unified "science" of collective action. There is no weight of experience to generate a commonly accepted set of abstractions to the extent that is apparent in individual approaches. Collective action has been studied seriously for only several decades and has been approached quantitatively and mathematically for only a number of years.

This statement does not give credit to separate disciplines which have, in their own way, attacked the collective decision problem and given considerable formalization to its analysis. However, this has generated considerable fragmentation in concepts, terminology, and other features of any effort to unify or even to classify these models. For example, concepts like "satisficing" or "incrementalism" can be identified in most areas of study, including political, social, organizational, social psychological, and so on. Yet, each area adopts its own perspectives on these phenomena and formalizes their application in the ways which suit their needs best. A unified approach to the analysis of such factors which are common to many areas of study, does not exist. The best hope for such a common perspective seems to rest with a system perspective utilizing a breakdown between substance and process.

All of these difficulties point most emphatically to the need for a common frame of reference in any survey of collective action models. Chapter IV has proceeded from just such a common reference

position. However, the schema was not intended to solve all classification problems for collective models; indeed, it could be graded only as rudimentary in this regard. Moreover, the classification schema was formulated more with the problems of this research in mind than the problems of classification in general. But, the schema did introduce a degree of organization into the analysis which permitted Chapter IV to accomplish something, and it is hoped that the effort moved the "science" of collective action one small step toward a more unified perspective.

To recap quickly, "power" was considered to be a pervasive element in collective decisions, and as such, the way in which models included power considerations served a basic classificatory function. This provided a useful observation: most of the models which are familiar to us do not consider power to be an essential ingredient.

After this crude yes-no assessment of power (which should be refined later in the form of a continuum), collective action models were described by 9 decision components and an associated bipolar distinction along each component; there are, of course, more than 9. Following through with this logic, each physical decision situation and its analytical requirements can be described as a point in 9-space. Continuing the logic, it should be possible to find or devise a model which matches the requirements of this point in 9-space and thus increase the chance of harmony between decision model and decision situation. Conversely, if we are stuck for one reason or another, with a model which we must use, there exists the opportunity to

understand more precisely the ways in which our efforts do not measure up to the requirements.

The typology in Figure 4.10 helps to illustrate the search-and-comparison activity which is an implied requirement of the collective action approach. Consider for the moment that the collective decision situation can be represented by the two components shown in 4.10. Also assume that a model exists to fill each square (which is nearly the case).

Which squares describe the water resource decision problem? In one way or another, most. Which model(s) have traditionally dominated analytic approaches to the water problem? Primarily normative, unitary decision models lying in the upper left corner. Of course, no decision maker would suggest that his deliberations were dominated by this restricted analytical tool. More than likely he gathered all the technical information reasonably available and cast this in the normative unitary mold. All factors beyond the scope of this activity were probably handled in the following manner: (1) through past experience with his clientele and other members of the social unit, (2) with intuition and hunches, then (3) through an internalized subjective judgement considering the visible factors.

With the collective action approach this type of deliberation is no longer permitted; the problem of who gets what by which decision mechanism can no longer be addressed by narrowly specified models and implicit judgement alone. The other squares and the models they represent are now open for all to see, for the duration of the decision trajectory. The broadest range of factors are given visibility and

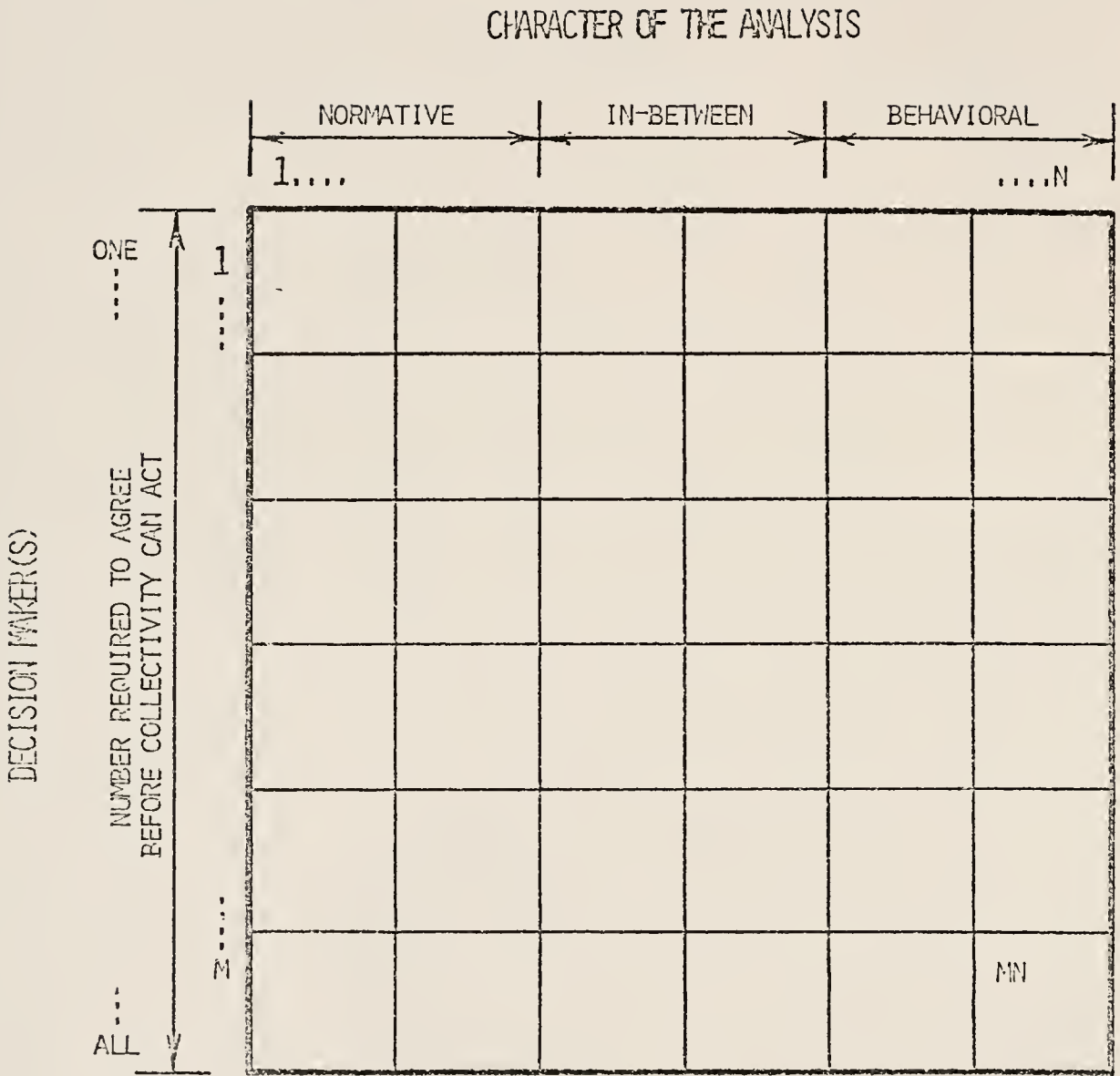


Figure 4.10 Two-Way Typology to Aid the Models' Summary

meaning in terms of the decision problem; *each square has some stake in the decision effort*. Likewise, no single square can be called right or best except as it stands in relation to all other squares. No single decision tool can be employed without standing in the glare of other mechanisms.

From this it becomes clear that the collective action approach will not make any decision maker's job easier. Indeed, it makes his job much more difficult; it introduces a broader range of complicating factors and leaves one with little hope of finding the "right" answer. This is the strength of the collective action approach; it shows us compellingly what we cannot do and thus what we must do. It shows us, if we employ one specific set of models, precisely what was left out. It makes the analyst, planner, concerned citizen, and whoever might be involved accountable for factors *not* considered. Our biases and the implications of our decisions become clearer as we reflect on squares not chosen.

The collective action approach is not without considerable hazards, though. Among these is the question, which model to use in the final analysis? This is not a new problem, however, since the value question must be solved in any circumstance, old or new. There is no answer to this yet available, only a consequence of the situation to be noted. Without the collective action approach, the value question was either presumed to be answered a priori or was answered arbitrarily without the aid of unifying or guiding principles. Now, even though the guiding principles suggested by the collective action approach may be considered rudimentary, the value question must be addressed explicitly,

if only through the continuous requirement to select and justify decision models. Hopefully, the collective action approach will do more than that; hopefully, the value question will become the first order of business, for without at least a partial effort the conceptual arena and its attendant activities will not move forward. This forces the value question to be considered.

How miniscule and strange a single decision index like the benefit-cost ratio now looks in the light of this array of collective decision models!

CHAPTER V

EXPLORATION OF A CONTROLLED ENVIRONMENT

To equate the worth of a theory . . . with ease of study, is a sophistical device which leads to a situation in which only those things are studied for which data already exist--which may help to account for that fantastic sameness and duplication of research efforts. . . .

--Irving Louis Horowitz [1962, p. 181]

Testing the Waters

In both the natural and social sciences, it is common for investigators to apply new methods or concepts to well-controlled situations before subjecting them to the complexities and impurities of the real world. Chemists use known concentrations and carefully controlled environments to evaluate proposed analytical techniques; behavioral scientists devise experimental games which hold nuisance variables constant so that factors of interest can be studied in the absence of unwanted complications.

The same logic will be followed here. Given the overarching framework for the collective action approach from Chapters II, III, IV, selected portions will be extended to a realistic water resource management problem. At this time it is not possible to relate the entire set of guiding principles to the case study; however, this use of certain selected components does not suggest that the foregoing

chapters should be shelved. Indeed, the two chapters to follow must be viewed in the context of the entire thesis, even though the organizing statements presented earlier will reveal many rough edges in both test cases.

This chapter in particular provides the opportunity for some comparisons which might not otherwise be available in the context of a typical water resource management study. Several independent investigators have applied techniques of their own to the same study area focusing on essentially the same water quality problem. Their efforts cover a range of contemporary approaches to such problems and yet have no direct connection with the overarching principles presented herein as the collective action approach. Thus, by including the results of their analyses, it should be possible to identify the biases, strengths, and weaknesses in each perspective and to get a better feeling for the collective action approach; whether it can be implemented in principle and whether it behaves reasonably and sensibly.

Bow River Valley

Bow River Valley, described by Dorfman and Jacoby [1969, 1971], serves as the test area for initial introduction of concepts presented in this thesis. The authors' objective was to construct a hypothetical but realistic water management problem which omitted unnecessary, complicating details yet retained the essential conflicts one would expect from this type of public decision problem. Their article should be consulted for a detailed description of the physical, technical, economic, social, and political conditions which exist in Bow Valley.

Figure 5.1 contains a schematic diagram of Bow Valley describing physical relationships between certain points of interest in the basin, the Cannery, Bowville, the State Park, Plympton, and the state line. In brief, during critical low-flow periods this river cannot properly assimilate the wastes discharged by the cannery and both municipalities. Conflicts have developed around the issue of poor river quality and in particular around the question of how much to increase the water quality and who will lose and gain in the process. Since, for this problem, water can be improved only by waste treatment at one or all of the three discharge points, the Bow Valley participants must agree on a level of waste treatment at each point that will enhance overall water quality, yet will also strike a balance among the diverse points of view represented in the conflict.

Appendix A contains a summary of essential physical, technical, and economic details; these include river characteristics, the critical period dissolved oxygen profile, waste loadings, treatment costs, benefits for stream improvement, and an associated linear programming model. Using this model one may (1) specify certain objectives like, minimize costs or maximize dissolved oxygen at the park, (2) introduce desirable constraints, like upper limits on costs or lower limits on the stream classification, and then (3) calculate degree of treatment required to accomplish the objective while simultaneously satisfying constraints.

In this fashion, the LP model was used primarily to generate an array of plans available later for more detailed analysis. A *plan*, then, can be defined as the specification of a single course of action including, for this basin, only treatment levels at the Cannery,

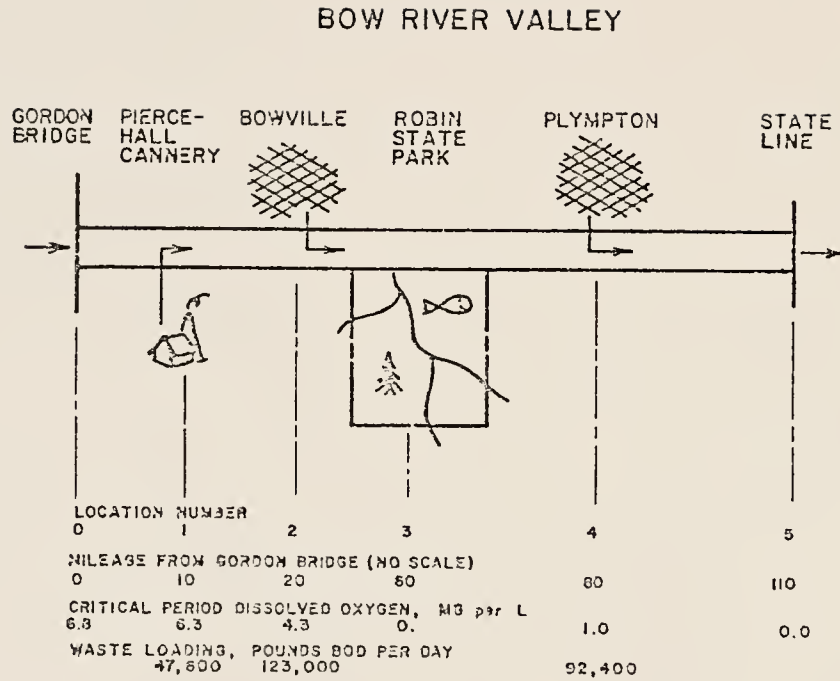


Figure 5.1. Schematic Diagram of Bow River Valley

Bowville, and Plympton. Each waste source already has primary treatment facilities rated at 30% BOD removal; each source can install secondary and tertiary facilities capable of removing a maximum of 95%. Hence, the range of possible treatment levels at each source is 30-95%, and a plan specifies a single level at each location. Even under this simplified arrangement an infinite number of plans are conceivable. Certain linear properties of the optimization model, however, reduce the total number which the model is capable of generating. Table 5.1 contains a description of five selected plans from a total of 158 generated during the course of this research. These five plans will be used to illustrate certain results later in this chapter and thus should not be viewed as exhaustive of all possibilities. As the table shows, the cannery and Plympton treatment levels are held constant while Bowville's requirement varies from 41-93%. Resulting dissolved oxygen levels, stream classifications, protection for endangered species, costs, and benefits also appear in the table to describe more fully the variations to be expected from different plans.

An Analytical Structure

Each plan in concept will generate a profile of physical, economic, and social consequences. Each set of treatment levels will have associated with it a dissolved oxygen profile for the river, a profile of benefits and treatment costs, an array of effects on the natural system, a number of social and political consequences, and so on. Thus, the plan by itself has little meaning in the management context without considering its profile of consequences.

Table 5.1 A Selection of Possible Bow Valley Plans

PLAN NO.	WASTE TREATMENT LEVELS				DISSOLVED OXYGEN LEVELS					STREAM CLASS	PROTECTION FOR ENDANGERED SPECIES %
	w ₁	w ₂	w ₃	w ₄	q ₂	q ₃	q ₄	q ₅	ST. LINE		
	CANNERY	BOWVILLE	PLYMPTON		BOWVILLE	ST. PARK	PLYMPTON		ST. LINE		
12	0.80	0.41	0.80		5.40	2.00	2.36	3.60		D	13
23	0.80	0.64	0.80		5.40	3.61	3.50	4.19		C	50
28	0.80	0.80	0.80		5.40	4.79	4.34	4.61		C	50
48	0.80	0.90	0.80		5.40	5.51	4.85	4.86		C	50
63	0.80	0.93	0.80		5.40	5.73	5.00	4.93		B	87

PLAN NO	WASTE TREATMENT COSTS				NET BENEFITS					
	c, \$1000 per year				b, \$1000 per year					
	CANNERY	BOWVILLE	PLYMPTON	WGO	CANNERY	BOWVILLE	PLYMPTON	WGO		
	c ₁	c ₂	c ₄	c ₆	b ₁	b ₂	b ₄	b ₆		
12	8	109.7	410.1	708.7	-8	- 19.9	-383.0	- 591.7		
23	8	328.6	410.1	999.1	-8	- 185.7	-249.4	- 644.8		
28	8	490.2	410.1	1213.4	-8	- 308.1	-150.9	- 684.2		
48	8	662.4	410.1	1446.5	-8	- 464.9	-101.4	- 838.8		
63	8	1395.1	410.1	2423.4	-8	-1194.0	- 87.9	-1795.7		

The theory and state-of-the-art for environmental impact statements (EIS) will not be reviewed here; however, in concept their purpose is to relate a plan to its profile of consequences. An EIS, then, can be viewed as "black box" which transforms a plan into a profile of consequences, suggesting a certain fundamental logical correspondence between "plan" and its "consequences." This basic correspondence has not been fully explored theoretically, but the relationship is strong enough to permit one to speak entirely in the mode "plan" or forget plan details and carry out the analysis in the mode "consequences," whichever is more convenient. It may even be possible to extend the logic with a degree of mathematical precision:

$$[P] \cdot [E] \rightarrow [C]$$

where,

[P] = matrix of courses of action

[E] = environmental impact statement

[C] = profile of consequences.

This type of logic was described in more elaborate detail in Chapter II beginning on page 50. Considering the total water resource management system, (1) expressed needs were transformed into a statement of water related activities [P], (2) water activities through interactions with natural and social systems were transformed into a statement of consequences [C], which (3) were compared to social aims to see if the activities satisfied expressed needs. Chapter II also related water resource management system to Parsons' General Theory of Action; this extension will not be discussed in detail at this point.

Continuing the logic of the previous paragraph, a profile of consequences alone does not complete the flow of information through the WRM system. Also, there must be a means for relating consequences to system goals and a means for investigating the integrative problem which surrounds any such allocation of advantages and disadvantages among members of the social unit. Chapters II and IV described the need to incorporate the *integrative subsystem* into one's overall analysis; this was directly reflected in the collective action approach.

Recent developments in Goals Theory begin to fulfill this need for relating immediate consequences to overall system functioning and the integrative problem. The idea here is to be able to relate plans or their consequences to the goals structure of a social unit and different groups within the unit. A thorough review of recent goals research will not be included here; however, the flavor of these efforts can be portrayed using, as a practical example, a goals hierarchy proposed by The Technical Committee [1971].

A goals structure can be defined as the logical disaggregation of goals and objectives beginning with the most general concerns and proceeding to those which are more specific. Following the suggestions of The Technical Committee, the *primary concern* of a group or social unit might be "promotion of the general welfare." To begin the disaggregation procedure, the authors divided this primary concern into two *social aims*, "maintenance of security" and "enhancement of opportunity." Each of these aims can be subdivided into *prime goals*, which can be further broken down into *subgoals* and *objectives* until more specific measurable parameters are defined as a part of the hierarchy:

I. Primary Concern:

Promotion of General Welfare

II. Social Aims:

A. Maintenance of Security B. Enhancement of Opportunity

III. Prime Goals:

- | | |
|---------------------------|---------------------------------------|
| 1. Collective Security | 1. Economic Opportunity |
| 2. Environmental Security | 2. Cultural and Community Opportunity |
| 3. Individual Security | 3. Aesthetic Opportunity |
| | 4. Recreational Opportunity |
| | 5. Individual Freedom and Variety |
| | 6. Educational Opportunity |

Figure 5.2 contains a partial goals hierarchy for Bow Valley showing how one prime goal, Environmental Security, might be disaggregated into water quality subgoals and then into dissolved oxygen as a social indicator. The logic here is that dissolved oxygen is a more specific, identifiable, and measurable parameter of interest; and, using the goals structure, any changes in an indicator like this can be related systematically to higher and higher, and thus more abstract social goals. Moreover, this array of social indicators can be equated with the profile of consequences discussed earlier, thus providing a link between the plan and its tendency to move us toward or away from social goals:

Recalling, $[P] \cdot [E] \rightarrow [C]$.

Also, $[C] = [SI]$

$$[SI] \cdot [T_1] = [O]; \quad [O] \cdot [T_2] = [G]; \quad [G] \cdot [T_3] = [A].$$

Thus, $[C] \cdot [T_1] \cdot [T_2] \cdot [T_3] = [A]$

where, [SI] = matrix of social indicators
 [O] = matrix of objectives
 [G] = matrix of goals
 [A] = matrix of aims
 $[T_i]$ = transformation between levels.

Figure 5.3 contains a full goals hierarchy for Bow Valley again following procedures outlined by The Technical Committee. The diagram shows only vertical relationships between water-related activities and social goals. In reality, lateral relations exist as well. Furthermore, more than one hierarchy will exist for a given problem since each affected group will construct one which best represents its own preferences.

The Local Collective Action "Structure"

Chapters II and IV emphasized the need to consider both structure and process during the analysis of water resource problems. For Bow Valley, the physical, technical, and economic structure have been presented. The foregoing section added more structure to the analysis by developing a goals hierarchy that relates plans and their consequences to a matrix of goals and objectives. This device was needed (1) to complete the analytical framework for this Bow Valley problem in accordance with the requirements spelled out in Chapter II, and (2) to impart some organizational clarity to the question of "issues" and "effects." The section to follow continues with the structure component by describing the primary interest groups and their relation to the overall problem. It should also be added here that "process"

GOALS HIERARCHY FOR WATER RESOURCES MANAGEMENT

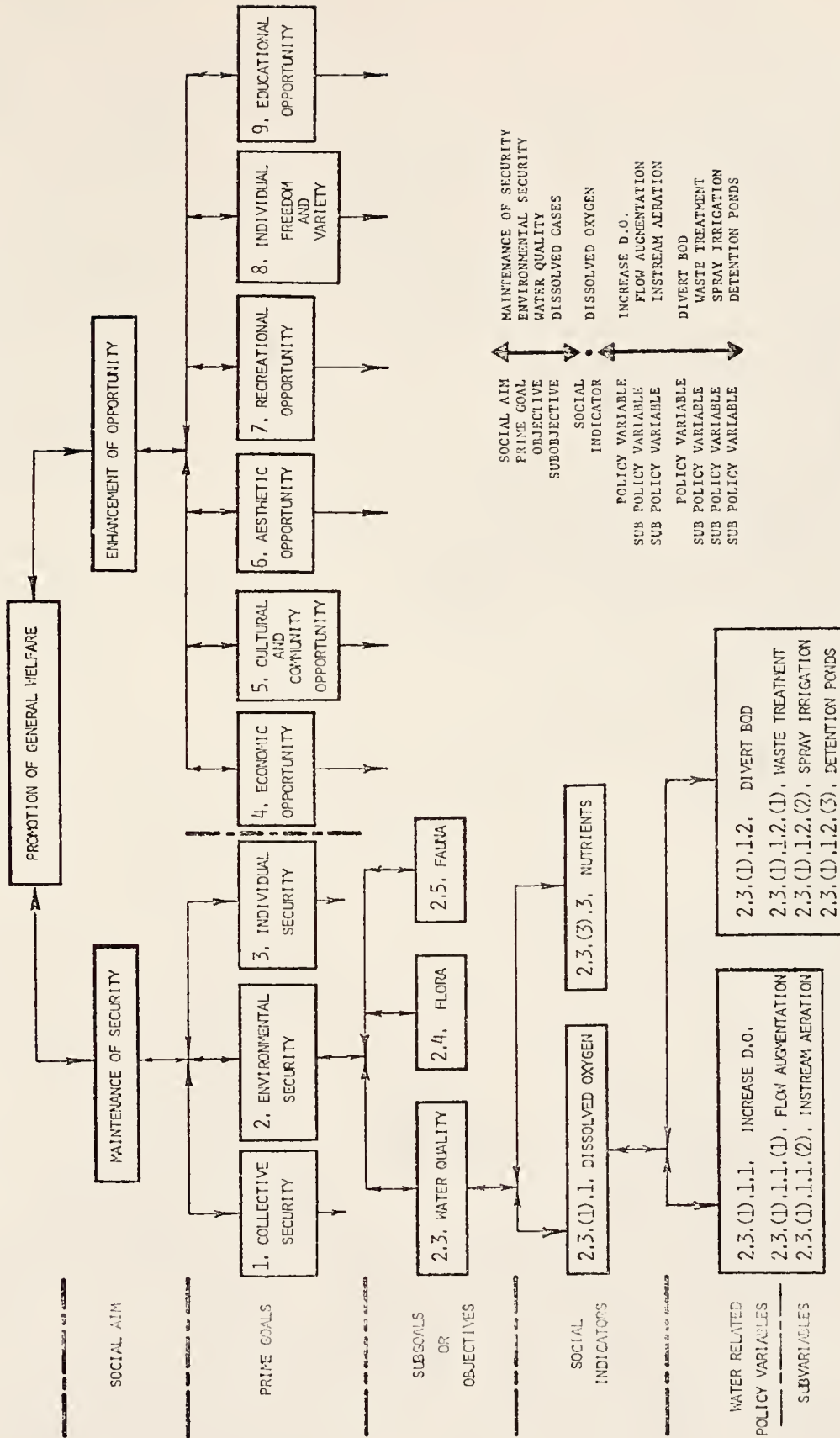


Figure 5.2. A Partial Goals Hierarchy for Bow Valley

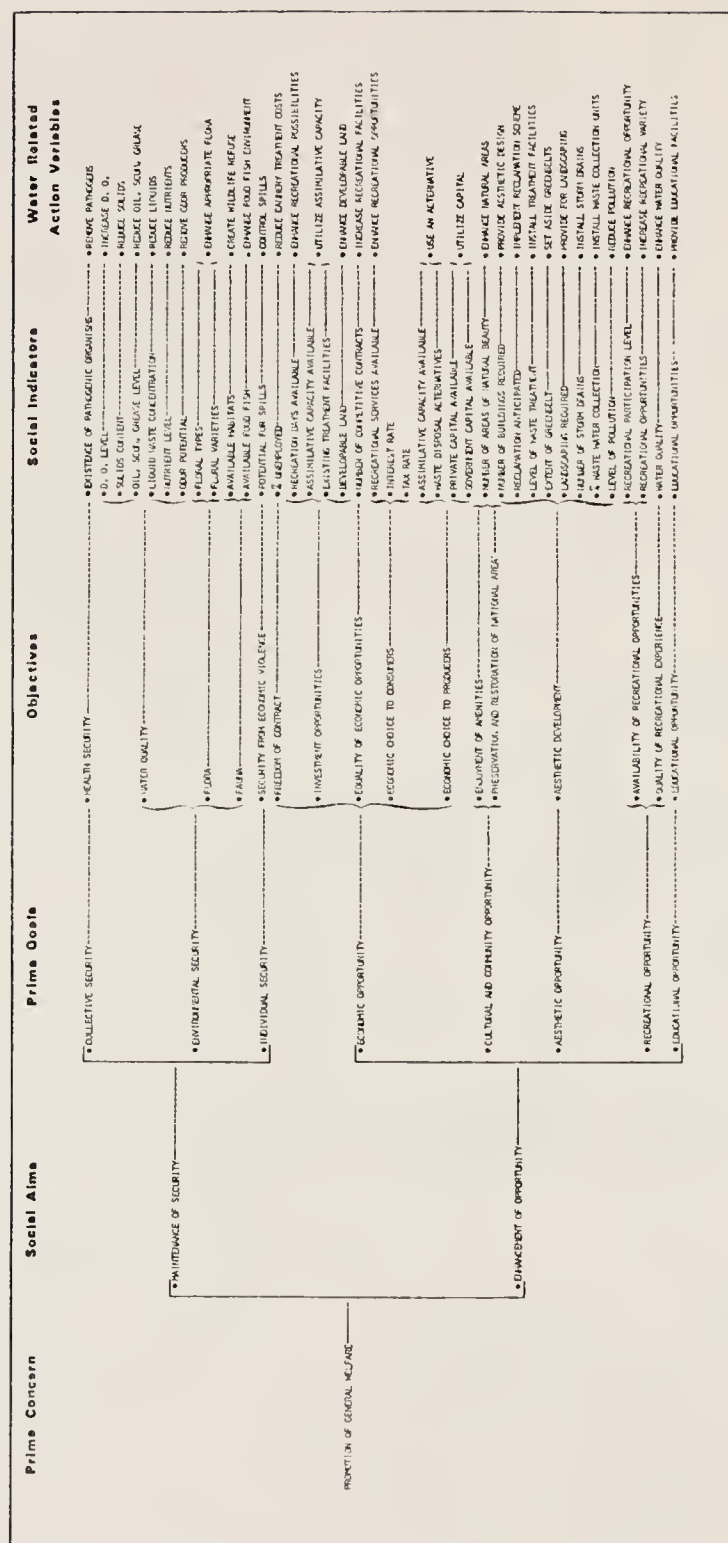


Figure 5.3. A Full Goals Hierarchy for Bow Valley

will receive only limited attention in the Bow Valley analysis. The original Dorfman and Jacoby report did not include information which would have permitted this. However, their description did permit the identification of the following interest groups:

- (1) *State Industrial Commission* has little stake in water quality but they oppose, at the state and local levels, any actions which may harm individual industries;
- (2) *Pierce-Hall Cannery* is a seasonal and marginal operation which, because they cannot afford treatment facilities, contributes to pollution at the upper end of the basin. Many residents of the area derive their livelihood from the Cannery, and a layoff would have important local consequences. The Cannery management does want better river quality, though, because their employees use the State Park for recreation, and they intend to relocate downstream in the future. Mr. Pierce is a member of the Bow Valley Water Pollution Control Commission, a respected businessman, and a dedicated fisherman;
- (3) *Bowville* is the largest single source of pollution, but their tax base is fairly strong, and they should be in a better position to pay for control facilities. They are not seriously concerned, however, about the effects of their wastes on the State Park and other points downstream. Bowville already has a nice waterfront park and would rather concentrate on the Cannery's pollution of their own recreational facilities;
- (4) *Plympton*. The wastes from Plympton affect no single receptor directly, yet its water is of poor quality because of upstream discharges. Also, Plympton has no waterfront recreational facilities and looks to Robin State Park as a source for its citizens. Thus, Plympton is eager to participate in a water quality program, but its tax base is lower and treatment facilities are harder to finance;
- (5) *Commercial recreationists*. Bow Valley has the potential for being a fine locus of recreational activities both for its own citizens and for outsiders who could be a valuable source of revenue. Poor river quality now prevents this. Commercial recreation interests along with their connections in the State Department of Parks and Recreation continually push for better water quality, especially at Robin State Park;
- (6) *Downstream state* has little to do with Bow Valley affairs directly; however, poor water quality from the upper reaches of Bow River is something they must contend with. Their main recourse is through the Water Quality Office of EPA which has responsibility for interstate waters;

- (7) *State Water and Sanitation Commission* has direct interest in the quality of all state waters, thus its influence will be somewhat diffuse. Sensitive areas like the State Park are of particular interest, however they generally look for a basin-side improvement in quality with less concern over who must pay;
- (8) *Bow Valley Water Pollution Commission*, hereafter called BVWPC, has final decision authority and must select first an overall stream classification (A,B,C, or D) and then the treatment levels which conform to the selected class. Obviously the focal point for all interest group pressure, they seek most of all to be fair to all concerned and would try hard not to impose an unrealistic burden on a single group;
- (9) *Bow River News* has been a leader in the fight to improve river quality using headlines like, "The Shame of Bow River Valley." Their capacity to mobilize public opinion is considerable;
- (10) *Plympton Chamber of Commerce* is a surprisingly powerful group that seeks to improve Plympton's decaying image. Outdoor recreation and good water are obvious targets for this group, but they had rather their own citizens not be burdened with a large share of the costs;
- (11) *Water Quality Office*, of EPA, hereafter called WQO, will split 50-50 the cost of waste treatment facilities. It is of little concern to WQO where these are located as long as the investment is high and their pipeline of projects can be kept full. Their influence lies primarily with their pursestring connections; and
- (12) *Izaak Walton League* has little voting power but much experience in mobilizing public support. This group also has connections with other national conservation groups and can call them into the conflict if necessary. Low water quality has a damaging effect on fish life, especially the Oxy Minnow. A species of water fowl, the Wading Waternut, depends on the minnow for its food supply. The League is primarily concerned with this endangered species.

Introducing Collective Action Analyses

The physical, technical, economic, social, and political features of my approach to the Bow Valley problem have purposely been kept as close to the Dorfman and Jacoby original as possible. The section to follow, including the goals hierarchy described earlier,

represents the major departure from their work by emphasizing those concepts from Chapters II, III, and IV loosely described as the collective action approach.

It is first possible to draw upon the General Theory of Action, in particular Figures 2.4 on page 47 and 2.11 on page 69, to identify the functional subproblems that dominate in the Bow Valley conflict. There will not be a one-to-one correspondence here, since these two figures were used to illustrate planning conditions with the substantial Federal involvement in final decision making. Compared to this, Bow Valley would not have policy decisions imposed by extra-local interests; however, they must solve the same functional subproblems. One, the goal attainment problem must be considered in which the needs and goals of the whole collectivity are satisfied. Satisfying collective goals leads to a resultant allocation of advantages and disadvantages, thus the integrative problem must be solved as well. As Figure 2.11 shows, if the BVWPC were substituted for the field level agency, the Commission must balance the tension that exists between extra-local interests concerned with collective goals and local interests concerned with disaggregate goals. Flows of power and influence (p. 47) are the major determinants of commitments to specific courses of action, i.e., plans.

Thus, plans (policies) result from collective interactions up and down between the two subsystems, and so the collective action approach can provide information on the quality of decisions that are or should be made. Although the BVWPC has final decision authority (Mode 5), with a decision rule which was not specified, Mode 4 has been

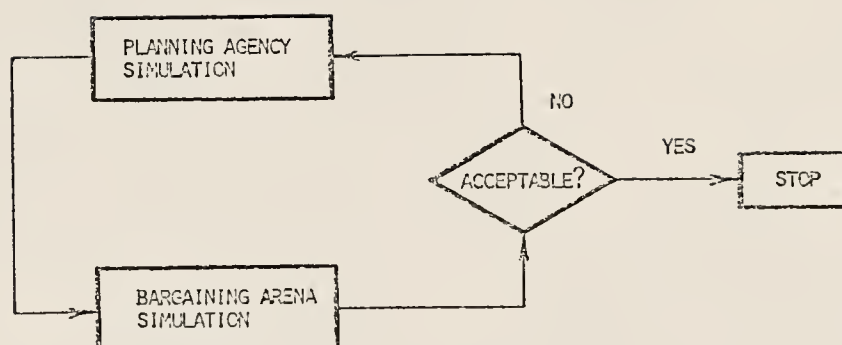
described earlier as the most useful climate for carrying out broad investigations. Also, here we can introduce the conceptual arena as a device for organizing the different interactions among local and extra-local interests. The analysis can as a result draw upon any of the models from Chapter IV depending on one's objectives: (1) to specify what plans should be recommended, (2) to predict how groups will behave, (3) to investigate the distribution of rewards, (4) to assist group interactions (if they can be called together), and many other as surveyed earlier.

Most water resource analyses of the Bow Valley type have been strongly normative in character either because of specific analytical techniques employed or the general intent reflected in planning behavior. To balance this tendency and to begin the introduction of a broader range of decision models, the following sections will describe the application of a behavioral simulation technique. The collective action simulation model, hereafter called CASM, draws heavily on the work of Bulkley and McLaughlin [1966] who developed a computer-based representation of agency behavior for a public works program in Chile. CASM is static in nature with only a suggestion of interaction processes over time. However, this deficiency is overshadowed by the model's emphasis on discrete groups and the manner in which they form coalitions to move decisions in one direction or another. If the model had lower resolving power, that is, lower than the focus on discrete groups, then an important behavioral element would have been lost. Thus, by concentrating on the behavior of individual groups, *as the basic unit of analysis*, those behavioral features which are important to the

collective action approach are given much more visibility. Even though certain factors like mass behavior and process interactions over time are lost in this model, the questions of winners and losers and the dispositions of interactive participants received greater emphasis by the focus on the individual decision behavior of each group.

Thus, the analysis takes place in Mode 4 (see p. 135); we prefer that participants be actively involved. However, as might often be expected, there exist no public involvement programs in Bow Valley. Instead, interested groups try to influence the BWPC by any means at their disposal. The possible nonexistence of participation programs has been discussed on pages 136 and 246. This reality does not bump the analysis out of Mode 4; however, we must look to other surrogate devices which help the analytical team to *act in good faith*, as if the collective action approach were being applied on a full-scale basis.

Figure 4.2 (p. 137) contains a schematic diagram which gives a useful abstraction of the conceptual arena and how it might connect different parts of the (conjoint) planning process. In general, the arena serves as the setting for interactions between proposed plans and participants in the social decision trajectory, transpiring over a sequence of iterations. We wish to duplicate that as closely as possible and thus adopt the logic as described in Figure 5.4. The linear programming model generates plans and can be used to represent planning (or policy) output from the BWPC, or whoever is responsible for technical input to the arena. Then, using CASM the overall response to each proposed plan can be studied: proposed plan--accepted or not accepted--revised plan--and so on until the process terminates.



CONCEPTUAL PLANNING SCHEME

Figure 5.4. Logic of Bow Valley Collective Action Analysis

(See page 147 for an introduction to the problem of when to stop the arena.)

Bow Valley CASM

Given now, the more complete structure of the Bow Valley problem and the logic of this (limited) collective action analysis, it is appropriate to proceed with a fuller description of CASM and the results which emerge from this exercise.

First, CASM and most models of collective action need a focus for interactions, a plan, a candidate, a set of issues, or something similar. For this exercise, any plan can serve as the appropriate focus. Not to be limited to a unidimensional analysis, each plan was disaggregated into an array of components which collectively could convey the essential features of each proposal. A variety of disaggregation schemes could be followed:

- (1) Physical plan descriptions, amount of flood control, irrigation, etc.;
- (2) Political issues raised;
- (3) Contributions to various goal categories, national efficiency, regional development, etc.;
- (4) Effects on groups and/or economic sectors;
- (5) An array of social indicators; or possibly
- (6) Some mixture of these or others.

It is not clear whether one single category should be consistently employed or not. However, for Bow Valley an array of social indicators was used to describe each plan and to serve as the set of issues which focus the attention of all groups. As described in an earlier paragraph, the indicators or consequences can be used both as

a descriptor of any plan and as a device for relating a plan to overall social goals. It is naive to suggest that each group can or will perceive the water problem in terms of a *homogeneous* category of disaggregated elements. More likely each participant perceives the situation as a mixture of physical properties, political issues, indicators, and so on. Thus, a great deal of careful study should be devoted to the problem of selecting the appropriate set of components.

For this initial exploration, however, the purposes of the analysis are not subverted by adhering to a single homogeneous category including only social indicators. Fortunately as it turns out, some indicators look like issues, others like physical features, still others like other different groupings. Figures 5.2 and 5.3 introduced the goals hierarchy and social indicators pertinent to Bow Valley. After selecting those which were most pertinent and easiest to handle, the following list of social indicators was adopted to facilitate the application of CASM.

Social Indicators of the Bow Valley Problem

1. Cannery treatment costs
2. Bowville treatment costs
3. Plympton treatment costs
4. WQO costs
5. Dissolved oxygen at Bowville
6. Dissolved oxygen at State Park
7. Dissolved oxygen at Plympton
8. Dissolved oxygen at State Line
9. Stream classification
10. Protection provided for endangered species

It is suggested by this listing that each plan can be described in terms of a measure along each component; that is, each plan represents a point in 10-space. Table 5.1 contained data describing 5 plans used to illustrate the CASM and its performance. To assist the simulation each indicator has been scaled from 0.0 to 1.0; the 5 plans "scaled" are summarized in Table 5.2. As an aside, it should be mentioned that scaling efforts are infused with many complex problems not conveyed by Table 5.2. The following sources should be consulted for more information on the theory, problems, and techniques of "scaling" [Hodge, 1963; Stevens, 1946, 1966; Torgerson, 1958; Coombs, 1950, 1964; Fishburn, 1964; Shepard, 1972; Ellis, 1968; Zinnes, 1969].

Data like those presented in Table 5.2 are intended to portray the physical, technical, and economic structure of the Bow Valley problem, in a manner that is useful to CASM. It is next necessary to describe the social structure and the procedure by which participants are assumed to arrive at decisions regarding proposed plans. A technical description of the complete model can be found in Appendix B along with a listing of the source program. A more general description will be provided here to insure some continuity through the chapter.

First, CASM requires an identification of participants and issues; 12 interest groups and 10 issues were described earlier.

In addition, for each group the following data are required:

- (1) *Ideal goals* relative to each project component;
- (2) *Aspiration levels*, the degree of satisfaction above which a component is acceptable even though ideal goals may not be met;
- (3) *Exasperation levels*, the degree of satisfaction below which a component will be unacceptable;

TABLE 5.2. A SUMMARY OF "SCALED" BOW VALLEY PLANS

Plan Number	INDICATOR NUMBER									
	1	2	3	4	5	6	7	8	9	10
		Treatment Costs (Fraction of Maximum) Cannery Bowville Plympton		WQO	Dissolved Oxygen (Fraction of Saturation) Bowville State Park Plympton			State Line	Stream Classification of (Fraction of highest class)	Degree of Protection for Endangered Species
12	0.08	0.06	0.26	0.15	0.72	0.27	0.31	0.48	0.32	0.13
23	0.08	0.17	0.26	0.21	0.72	0.48	0.47	0.56	0.47	0.50
28	0.08	0.26	0.26	0.25	0.72	0.64	0.58	0.61	0.47	0.50
48	0.08	0.35	0.26	0.30	0.72	0.73	0.65	0.65	0.47	0.50
63	0.08	0.74	0.26	0.51	0.72	0.76	0.67	0.66	0.61	0.87

- (4) *Ideological position* of each group, toward each component, scaled from most negative (-1.0) to most positive (+1.0);
- (5) *Realtive power* of each group; and
- (6) The component which is highest on a group's salience ranking.

Table 5.3 contains data describing the ideal goals, aspiration levels, and exasperation levels for each group relative to each project component. This table describes as well the goals structure which might exist if each group maintained a "soft line," one characterized by a willingness to cooperate and compromise; Table 5.4 contains similar information but this time describes the goals structure of groups unwilling to cooperate or compromise, thereby adopting a "hard line" position. The ideological positions, from -1 to +1, for each group relative to each component appear in Table 5.5. Data required to calculate relative power values are presented in Table 5.6. Appendix B outlines the technical details of these calculations: to summarize, there are identified, first, 18 resources for power which a group might use in the collective action process; second, the relative degree to which each group might utilize each power resource is ranked from 0 to 10; third, in *this* political context as a whole, the importance of each power resource is weighted from 0 to 50. For each group, a political power "score" can be calculated by multiplying the resource weight times the degree of utilization for each component and summing across all 18 components. Table 5.7 summarizes relative power for each collective action participant, determined by using this procedure. Table 5.8 specifies the project component which is highest on each group's salience ranking; that is, the attribute which is most important to the group regardless of whether the group opposes or approves of that component.

TABLE 5.3. GOALS STRUCTURE FOR EACH GROUP UNDER "SOFT LINE" POSITIONS

GROUP NUMBER	ITEM	PROJECT COMPONENT									
		1	2	3	4	5	6	7	8	9	10
1	WGOALS	0.00*	1.00	1.00	1.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	TVYES	0.95	0.35	0.20	0.40	0.40	0.40	0.40	0.40	0.45	0.50
	TVNO	0.65	0.20	0.15	0.25	0.25	0.25	0.25	0.25	0.27	0.13
2	WGOALS	0.05*	1.00	1.00	1.00	0.50	0.50	0.50	0.35	0.00*	0.00*
	TVYES	0.90	0.35	0.35	0.40	0.40	0.40	0.40	0.30	0.45	0.50
	TVNO	0.65	0.25	0.25	0.25	0.30	0.30	0.30	0.00	0.35	0.13
3	WGOALS	1.00	0.15*	1.00	1.00	0.75	0.75	0.50	0.40	0.61	0.80
	TVYES	0.35	0.86	0.35	0.40	0.68	0.65	0.30	0.15	0.45	0.50
	TVNO	0.20	0.75	0.25	0.25	0.60	0.60	0.20	0.00	0.30	0.40
4	WGOALS	1.00	1.00	0.10*	1.00	0.50	0.80	0.70	0.40	0.61	0.80
	TVYES	0.35	0.35	0.82	0.40	0.30	0.75	0.55	0.15	0.45	0.50
	TVNO	0.20	0.25	0.70	0.25	0.20	0.70	0.40	0.00	0.30	0.40
5	WGOALS	1.00	1.00	1.00	1.00	0.75	0.85	0.70	0.80	0.70	1.00
	TVYES	0.35	0.35	0.35	0.40	0.65	0.78	0.65	0.55	0.65	0.80
	TVNO	0.25	0.25	0.25	0.25	0.60	0.70	0.50	0.30	0.45	0.55
6	WGOALS	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.85	0.70	1.00
	TVYES	0.75	0.75	0.75	0.80	0.60	0.60	0.60	0.80	0.60	0.85
	TVNO	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.70	0.45	0.40
7	WGOALS	0.75	0.75	0.70	0.70	0.70	0.75	0.70	0.70	0.90	1.00
	TVYES	0.34	0.45	0.40	0.50	0.60	0.65	0.60	0.60	0.80	0.85
	TVNO	0.25	0.35	0.35	0.40	0.45	0.50	0.45	0.40	0.35	0.40
8	WGOALS	0.08*	0.26*	0.25*	0.15*	0.70	0.70	0.70	0.50	0.61	0.75
	TVYES	0.40	0.40	0.40	0.85	0.68	0.68	0.65	0.35	0.45	0.50
	TVNO	0.35	0.35	0.35	0.70	0.45	0.50	0.45	0.30	0.30	0.40
9	WGOALS	0.80	0.80	0.80	1.00	0.75	0.80	0.70	0.50	0.90	1.00
	TVYES	0.40	0.40	0.40	0.80	0.70	0.70	0.60	0.40	0.80	0.90
	TVNO	0.25	0.35	0.35	0.35	0.50	0.60	0.50	0.30	0.50	0.55
10	WGOALS	1.00	1.00	0.70	1.00	0.75	0.80	0.85	0.50	0.70	0.80
	TVYES	0.45	0.45	0.35	0.50	0.40	0.70	0.78	0.40	0.60	0.70
	TVNO	0.25	0.35	0.20	0.40	0.20	0.60	0.70	0.30	0.45	0.55
11	WGOALS	0.70	0.75	0.70	0.85	0.70	0.70	0.70	0.70	0.70	0.80
	TVYES	0.35	0.35	0.35	0.80	0.55	0.55	0.55	0.60	0.65	0.70
	TVNO	0.25	0.35	0.35	0.55	.40	0.40	0.40	0.50	0.40	0.50
12	WGOALS	1.00	1.00	1.00	1.00	0.75	0.80	0.70	0.80	0.80	0.90
	TVYES	0.35	0.45	0.45	0.70	0.70	0.75	0.65	0.75	0.65	0.90
	TVNO	0.25	0.35	0.35	0.35	0.60	0.60	0.60	0.60	0.61	0.75

* Negatively sloped preference function; all others positively sloped.
WGOALS = Ideal goals. TVYES = Aspiration level. TVNO = Exasperation level.

TABLE 5.4. GOALS STRUCTURE FOR EACH GROUP UNDER "HARD LINE" POSITIONS

GROUP NUMBER	ITEM	PROJECT COMPONENT									
		1	2	3	4	5	6	7	8	9	10
1	WGOALS	0.00*	1.00	1.00	1.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
	TVYES	0.95	0.50	0.45	0.65	0.60	0.60	0.60	0.60	0.55	0.65
	TVNO	0.75	0.40	0.35	0.45	0.45	0.45	0.45	0.45	0.35	0.30
2	WGOALS	0.05*	1.00	1.00	1.00	0.50	0.50	0.50	0.35	0.00*	0.00*
	TVYES	0.90	0.50	0.65	0.65	0.45	0.45	0.45	0.30	0.55	0.65
	TVNO	0.70	0.40	0.45	0.45	0.40	0.40	0.40	0.20	0.40	0.40
3	WGOALS	1.00	0.15*	1.00	1.00	0.75	0.75	0.50	0.40	0.61	0.80
	TVYES	0.50	0.86	0.65	0.65	0.75	0.75	0.40	0.30	0.55	0.65
	TVNO	0.40	0.80	0.45	0.45	0.70	0.70	0.30	0.20	0.40	0.55
4	WGOALS	1.00	1.00	0.10*	1.00	0.50	0.80	0.70	0.40	0.61	0.80
	TVYES	0.50	0.90	0.85	0.65	0.50	0.75	0.60	0.30	0.50	0.65
	TVNO	0.40	0.80	0.80	0.45	0.40	0.70	0.45	0.15	0.45	0.50
5	WGOALS	1.00	1.00	1.00	1.00	0.75	0.85	0.70	0.80	0.70	1.00
	TVYES	0.50	0.50	0.85	0.65	0.80	0.84	0.65	0.65	0.65	0.85
	TVNO	0.40	0.40	0.75	0.45	0.70	0.80	0.55	0.50	0.50	0.60
6	WGOALS	1.00	1.00	1.00	1.00	0.80	0.80	0.80	0.85	0.70	1.00
	TVYES	0.80	0.50	0.65	0.85	0.70	0.70	0.70	0.80	0.65	0.85
	TVNO	0.50	0.40	0.45	0.60	0.45	0.45	0.45	0.70	0.55	0.60
7	WGOALS	0.75	0.75	0.70	0.70	0.70	0.75	0.70	0.70	0.90	1.00
	TVYES	0.50	0.85	0.80	0.70	0.70	0.70	0.65	0.65	0.90	0.85
	TVNO	0.40	0.65	0.55	0.60	0.50	0.55	0.50	0.50	0.50	0.60
8	WGOALS	0.08*	0.26*	0.25*	0.15*	0.70	0.70	0.70	0.50	0.61	0.75
	TVYES	0.55	0.65	0.60	0.90	0.75	0.68	0.68	0.40	0.50	0.60
	TVNO	0.45	0.55	0.45	0.75	0.55	0.60	0.55	0.35	0.45	0.50
9	WGOALS	0.80	0.80	0.80	1.00	0.75	0.80	0.70	0.50	0.90	1.00
	TVYES	0.50	0.60	0.65	0.85	0.70	0.70	0.65	0.45	0.90	0.90
	TVNO	0.35	0.50	0.45	0.55	0.65	0.65	0.55	0.40	0.80	0.70
10	WGOALS	1.00	1.00	0.70	1.00	0.75	0.80	0.85	0.50	0.70	0.80
	TVYES	0.65	0.60	0.65	0.70	0.70	0.70	0.85	0.45	0.65	0.70
	TVNO	0.40	0.50	0.50	0.55	0.50	0.65	0.78	0.35	0.50	0.60
11	WGOALS	0.70	0.75	0.70	0.85	0.70	0.70	0.70	0.70	0.70	0.80
	TVYES	0.50	0.55	0.65	0.80	0.65	0.65	0.65	0.60	0.65	0.70
	TVNO	0.40	0.55	0.45	0.70	0.45	0.45	0.45	0.50	0.50	0.55
12	WGOALS	1.00	1.00	1.00	1.00	0.75	0.80	0.70	0.80	0.80	0.90
	TVYES	0.50	0.65	0.65	0.75	0.70	0.70	0.65	0.75	0.70	0.90
	TVNO	0.40	0.55	0.45	0.45	0.65	0.65	0.60	0.65	0.65	0.75

* Negatively sloped preference function; all others positively sloped.

WGOALS = Ideal goals. TVYES = Aspiration level. TVNO = Exasperation level.

TABLE 5.5. IDEOLOGICAL POSITION OF EACH GROUP TOWARD EACH PROJECT COMPONENT

GROUP NUMBER	PROJECT COMPONENT									
	1	2	3	4	5	6	7	8	9	10
1	-0.85	0.45	0.15	-0.90	-0.50	-0.50	-0.50	-0.50	-0.50	-0.40
2	-0.40	0.30	0.20	0.20	-0.35	-0.45	-0.35	-0.40	-0.25	-0.20
3	0.15	-0.25	0.30	0.20	0.35	0.40	-0.35	-0.20	-0.20	0.0
4	0.30	0.65	-0.15	0.20	0.40	0.50	0.65	-0.30	-0.10	0.0
5	0.75	0.70	0.30	0.70	0.50	0.80	0.50	0.50	0.25	0.30
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50
7	0.65	0.60	0.60	0.35	0.70	0.85	0.70	0.60	0.30	0.30
8	0.20	0.35	0.40	-0.35	0.40	0.80	0.20	0.15	0.0	0.20
9	0.85	0.80	0.60	0.70	0.80	0.85	0.70	0.60	0.80	0.80
10	0.90	0.95	0.80	0.85	0.60	0.85	0.90	0.25	0.60	0.40
11	0.85	0.80	0.80	0.95	0.80	0.90	0.80	0.80	0.80	0.80
12	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.80	0.85	0.85

-1 = most negative ideological position

+1 = most positive ideological position

TABLE 5.6. INVENTORY OF POWER RESOURCES FOR EACH GROUP

POWER RESOURCES:		POWER RESOURCE COMPONENT																	
GROUP	NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		1. City size, budget, area, population 2. Consultants and experts hired 3. Grant incentives, compensation 4. Legal authority factor 5. Active BVWPC membership 6. Past performance record 7. Pull with Federal agencies 8. Pull with State agencies 9. Pull with local agencies 10. Pull with interest groups 11. Mobilization of public support 12. Lobbying skill, experience 13. Commitment factor, activation intensity 14. Entice "outside agitators" 15. Regulatory, bargaining, coercive ability 16. Fiscal solvency, bonds, tax base 17. Freedom from outside pressures 18. Public respect, position, image																	
1	0.0	0.0	2.0	2.0	2.0	5.0	5.0	5.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	4.0	2.0	4.0	2.0
2	1.0	2.0	10.0	4.0	8.0	0.0	3.0	3.0	5.0	8.0	2.0	4.0	0.0	0.0	8.0	5.0	3.0	5.0	4.0
3	5.0	3.0	6.0	3.0	5.0	0.0	1.0	1.0	10.0	7.0	10.0	4.0	0.0	1.0	8.0	7.0	4.0	4.0	6.0
4	4.0	3.0	4.0	4.0	5.0	0.0	1.0	1.0	7.0	6.0	6.0	4.0	0.0	1.0	8.0	6.0	4.0	3.0	5.0
5	6.0	5.0	8.0	5.0	6.0	0.0	7.0	7.0	0.0	5.0	2.0	3.0	0.0	0.0	8.0	4.0	5.0	6.0	5.0
6	0.0	0.0	1.0	1.0	8.0	2.0	7.0	7.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	10.0	0.0	0.0
7	2.0	2.0	8.0	4.0	6.0	7.0	9.0	4.0	4.0	6.0	5.0	7.0	0.0	4.0	0.0	6.0	8.0	10.0	5.0
8	5.0	5.0	10.0	6.0	6.0	3.0	9.0	9.0	0.0	10.0	3.0	2.0	0.0	0.0	0.0	8.0	6.0	7.0	8.0
9	10.0	10.0	0.0	7.0	2.0	0.0	5.0	5.0	0.0	10.0	0.0	0.0	0.0	0.0	10.0	8.0	2.0	8.0	10.0
10	7.0	7.0	7.0	5.0	2.0	0.0	2.0	2.0	0.0	8.0	2.0	0.0	0.0	0.0	0.0	4.0	2.0	6.0	8.0
11	0.0	2.0	6.0	3.0	0.0	10.0	1.0	1.0	0.0	6.0	6.0	10.0	10.0	5.0	0.0	10.0	6.0	5.0	6.0
12	10.0	8.0	8.0	10.0	10.0	0.0	10.0	0.0	0.0	6.0	0.0	7.0	0.0	0.0	0.0	4.0	2.0	5.0	6.0
Component Weight	5.0	50.0	30.0	40.0	5.0	20.0	20.0	1.0	1.0	1.0	25.0	20.0	30.0	50.0	30.0	1.0	5.0	5.0	5.0

TABLE 5.7. SOCIAL POWER OF BOW VALLEY DECISION PARTICIPANTS

GROUP	RAW POWER "SCORE"	RELATIVE POWER
(1) State Industrial Commission	483	0.033
(2) Pierce-Hall Cannery	1113	0.077
(3) Bowville	1234	0.085
(4) Plympton	1094	0.075
(5) Commercial Recreationists	1329	0.091
(6) Downstream State	490	0.034
(7) State Water and Sanitation Comm.	1456	0.100
(8) BVWPC	1823	0.125
(9) Bow River News	1358	0.093
(10) Plympton Chamber of Commerce	987	0.068
(11) WQO	1621	0.112
(12) Izaak Walton League	1555	0.107
Sum	14543	1.000

TABLE 5.8. MOST IMPORTANT PROJECT COMPONENT FOR EACH GROUP

GROUP NUMBER	MOST SALIENT COMPONENT	
	Component Number	Component Identification
1	1	Cannery costs
2	1	Cannery costs
3	2	Bowville costs
4	3	Plympton costs
5	6	D.O. at State Park
6	8	D.O. at State Line
7	9	Stream classification
8	4	WQO costs
9	9	Stream classification
10	7	D.O. at Plympton
11	4	WQO costs
12	10	Endangered species

Given the Bow Valley issues (social indicators) and the proclivities of the twelve major participants in the social decision trajectory, it is now appropriate to describe the manner in which decisions will be taken.

Before outlining the simulation logic, it will be useful to relate Bow Valley circumstances briefly to the total array of collective decision models presented in Chapter IV. In real life, one would describe the Bow Valley decision process most accurately by the model of community decision making qualified by an unspecified degree of "incrementalism." The decision would in actuality evolve and mature over a length of time relying heavily on informal bargaining and mutual accommodations. Pressure and counter-pressure would move the process through a series of phases until a final decision could be taken. Considering the realities of this incremental slowly moving process, the application of CASM could legitimately be labeled a mechanical representation of real political decision making and all its "incremental" complexities. However, it was never intended to duplicate exactly the local community decision process. Also, at the other extreme, the intent was never to prescribe an overall (normative) value position as a guide to correct decisions. Instead, the intent was to probe into the collective action analysis and to include representative features of actual group decision and coalition behavior as a means of *bridging the gap* between strictly normative and strictly behavioral perspectives.

Turning now to the decision logic employed in CASM, only a brief abstract will be presented here; more complete details can be found in Appendix B. However, the following general steps are used to simulate participant reactions to a *single*, given plan:

- (1) Each group looks at the array of issues and picks the one (later versions extend this to three) issue most salient to themselves;
- (2) Observing the level of performance along his most salient component, provided by the plan in question, and comparing this performance to his ideal goals and levels of aspiration and exasperation (Tables 5.3 and 5.4), the group decides to support or oppose the given plan. This yields, after all groups have acted, two coalitions, one for and one against;
- (3) To begin the consolidation process, a member of each side must be chosen as leader. He is selected on the basis of his power and the amount he stands to lose or gain from the proposed plan, considering his goals structure and personal proclivities;
- (4) Given a leader for each side, the degree to which members can be bonded into a cohesive unit can be determined. In essence, members leave the coalition if they share an ideological conflict with its leader as determined by data in Table 5.5;
- (5) After these interactions are completed, the arena is left with two "thinned out" coalitions. The plan under question will stand or fall based on comparisons of power, votes, or other properties of the two aggregates. Because of certain probabilistic components in the model, this total procedure is repeated 100 times for each proposed plan to obtain a relative frequency by which a plan passes or fails, for which a participant behaves in one way or another, and so on.

Considering again the total array of models surveyed in Chapter IV, this simulation treads softly on a number of points: groups reduce their considerations to a very low number number of issues; interpersonal conflicts are only weakly defined; conflict resolution and interpersonal interactions are lightly touched; the dynamics of all relationships enter at most implicitly. However, part of its strength lies in its parsimony along with the fact that many features of collective decision making

have still been included, to the extent that an analytical team must face them explicitly. Furthermore, Bulkley and Antill [1971] report surprisingly good predictive results using a similar model; each verification, though, only means that the model worked in that situation and little can be said about its performance in the next.

Sample Results from CASM

Before exploring sample results from this type of analysis, it will be useful to examine a typical computer output to become acquainted with the range and format of information available.

Figures 5.5 and 5.6 contain examples of this, for a typical plan, showing the following results:

- (1) Relative frequency with which a plan passes, fails, or ties;
- (2) Specification of conditions for decision, including soft vs hard line, decision rule employed, and type of conflict assumed;
- (3) Relative frequency with which groups occupy leadership positions;
- (4) Cumulative power, mean and standard deviation, for each side in the conflict; and
- (5) Behavior of each group including relative frequency with which he casts "yes" and "no" votes and frequency with which the participates in successful, losing, or tied efforts.

Given the availability of this information, the five selected plans (Table 5.2) can be submitted to CASM remembering that a wide variety of other possible plans exist and that, because of a random component in CASM, two separate submissions of the same plan may yield slightly different frequencies. It becomes a task of the analytical team to decide when to limit the search for alternatives and when frequencies for each plan have been satisfactorily defined.

Consider, for example, how the conflict might ebb and flow as a function of a range of submitted plans. The simulated arena has infinite sensitivity; groups can decide whether to vote "yes" or "no" on the basis of very small changes in project components. Using a large number of plans, thus permits one to plot group and arena responses as a continuous function of plan modifications. Of course, it is unreasonable to expect such sensitivity from actual participants in complex real-world circumstances. Furthermore, the "rule of sevens" must be considered. Empirical studies have found that human cognition can rarely hold, at one time, more than seven different plans, goals, criteria, or whatever. Usually the number is somewhat smaller than seven. Keeping this firmly in mind, it does not hurt to extend the analytical tool as far as it will go and to present results in the form of smooth curves.

Again, as an introduction to CASM results, consider how the conflict might shift in response to a range of possible plans. Presenting findings like this immediately becomes a problem. Since each plan can be defined as a point in n -space, here 10-space, it becomes difficult to find a common axis for analysis in much the same way that problems with multiple variables are difficult to display on two-dimensional graphs. However, for illustration, we can examine the arena response to plans as they vary from low regional costs to high regional costs, defined as the sum of treatment costs to the Cannery, Bowville, Plympton, and WQO. Thus, under this approach all plans considered would be ranked according to their total regional costs;

this ranking usually arranges plans from low water quality to high quality, as well.

Figure 5.7 contains a plot of arena responses as a function of regional costs. To keep the diagram simple only three variables are displayed: the probability that a plan meets with success, power of the anti-pollution forces, and power of the waste discharge forces. It is not quite fair to stereotype so strictly each side in the conflict. An examination of the prevailing leadership for each coalition for each plan would permit a more reflective description; however, these two basic groups do capture the essence of the Bow Valley conflict.

One thing to notice from Figure 5.7 is that the probability that a plan is successfully received increases as more money is spent. By focusing on acceptance as a guiding criterion, this diagram suggests very strongly that it may be useless to recommend plans with low regional costs, unless for some reason it is desired to stir the embers of local conflict. For, the local climate rejects the idea of marginal water quality and reflects a desire for an improved environmental image for Bow Valley. Furthermore, the desirable levels of waste treatment investment are more clearly defined than one might expect. Inspecting the probability curve shows that success does not increase uniformly from low to high. Instead, there appears to be a rather sharp break, a threshold, below which acceptability is low and above which plans receive substantial support. This type of threshold behavior was typical for the Bow Valley problem, including the sets of plans other than those plotted in Figure 5.7. Thus, it is clearer, than would be expected in most water management problems, who seems to win and lose

INFLUENCE OF REGIONAL PLANS ON ACCEPTABILITY AND POWER DISTRIBUTION

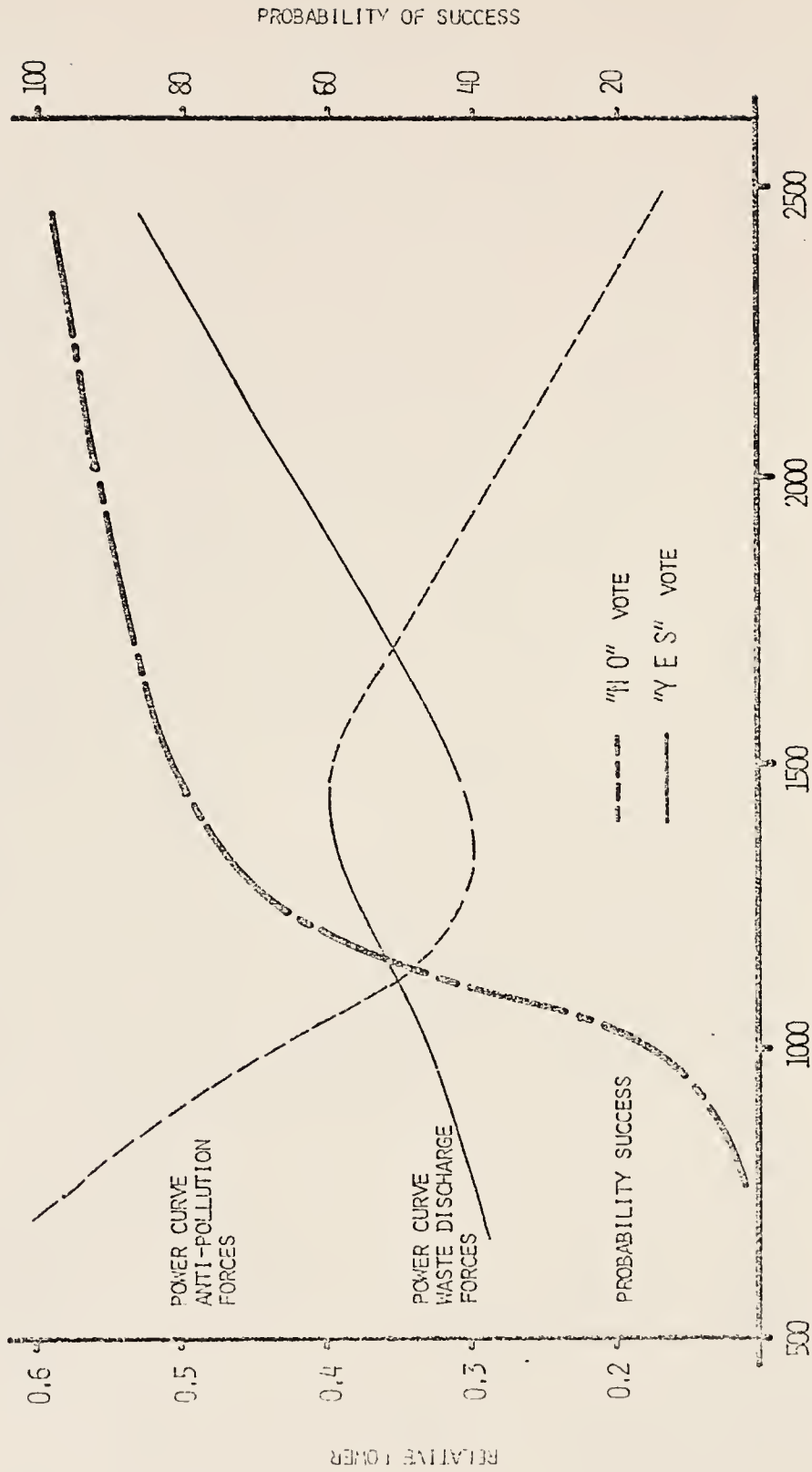


Figure 5.7. The Shift in Conflict Over a Range of Bow Valley Plans

and for which sets of plans. However, even though a general shape is maintained, one thing will shift the arena response curve. By investigating alternative decision rules (Figure 5.7 represents the rule requiring a plurality of power to win) the same plans will generate a variety of responses, thus a range of winners and losers and alternative distribution profiles. This introduces explicitly the question of equity and forces the BWPC to justify their decision procedures in terms of their inherent distribution profiles. At the very least, the collective action analysis dramatizes the direct link between decision model employed and the profile of consequences which flow from it. It emphasizes that, even though specific rules may be imposed or may be unavoidable, they can no longer exist unnoticed in the background of planning behavior. More specific CASM results will be presented later to illustrate this.

A closer inspection of Figure 5.7, and the CASM output which supports it, begins to show the types of detailed group responses which sharpen our analysis of the *integrative (subsystem)* problem. Cumulative power curves for each side describe the manner in which these two aggregates respond over a range of plans (more detailed behavior of each group can be observed in the output). It seems that, at the extremes of the Bow Valley problem, anti-pollution forces dominate. Where water quality is low, they vote "no" and muster the power to win decisively; where water quality is high, they vote "yes" and also consolidate the strength to win with little trouble. This aggregate, then, can be identified as the winner in these two ranges of water quality, and the specific participants who occupy each aggregate are

likewise winners. Less can be said for those participants who, because of ideological differences, dropped out of the conflict.

Moving to the middle range of regional costs, the power curves in Figure 5.7 are less specific as to winners and losers. In this range water quality begins to show improvement and yet costs are still moderate. Thus, those participants who are not committed to extreme positions may become detached from the conflict and act as crossover groups or "strange bedfellows." A wider variety of coalition leaders also emerges because the central issues shift as plans move along the continuum of regional costs.

The listing below illustrates the manner in which leadership and conflict shift as plans change. In general, at the extremes of the water quality continuum, the dominant issue is "water quality" spearheaded by groups who wish to protect it. In the middle range, anti-pollution forces lose strength and "waste treatment costs" moves ahead as the focus of arena concern. Actors which lead the fight in this range are less stereotyped by their ideological positions and the conflict as a whole is less stratified and more fluid than that at the extremes. As a note, though, even in the mid-range opposition forces still keep acceptably low or marginal, from 40% to 60%. It is not until water quality and regional costs rise substantially that the collective response becomes clearly affirmative.

PLAN NUMBER	REGIONAL COSTS	LEADER OF "NO" FORCES	LEADER OF "YES" FORCES
12	708.7	Izaak Walton League	BWPC
23	999.1	WQO	BWPC
28	1213.4	WQO	BWPC
48	1446.5	WQO	Commercial Recreationists
63	2442.3	Bowville	Izaak Walton League

Leaving for now this short exploration of the Bow Valley integrative problem, it is necessary to consider briefly arena responses to variations in the behavioral climate. For instance, how would the prevailing level of cooperation influence arena output? Looking back at page 159, it was presumed that the dominant mode of arena activity would be some type of "structured conflict" ranging from games of strategy to forms of persuasion. One way to represent this variation is to adopt a goals structure for each group which will permit a flexible position, ranging from a compromising "soft line" to an uncompromising "hard line" (see Tables 5.3 and 5.4). To repeat, the CASM does not include explicitly the manner in which groups actually interact and respond to each other over time. But, by permitting individual participants to adjust their positions independently, we can begin to understand how such forces might affect the arena response. For example, the first 65 plans explored, which cover a full range of possibilities, were submitted to CASM (1) with everyone assuming a "soft line" and again (2) with each group in a "hard line" position.

How does the arena respond to changes in cooperative spirit? The graph in Figure 5.8 gives a feel for this by plotting the

probability of success for each plan under both "hard line" and "soft line" positions. For instance, plan number 15, say, would be represented by *one point* on the diagram, its success under non-cooperative conditions vs its success for compromising conditions. If acceptability were equal under both conditions, plans would fall along the 45 degree line. However, Figure 5.8 shows that more plans have a higher degree of success when participants are willing to compromise than when the opposite is true. (The shaded band is defined by plotting the 65 points, representing 65 plans.)

What preliminary information does an exercise like this provide for the analytical team? First, it reveals that the spirit of cooperation which penetrates arena activities has a considerable effect on arena output. But this effect is not uniformly felt throughout the range of plans. At the extremes of the regional costs (water quality) continuum there seems to be a convergence of results for both hard and soft line positions. For these extremes, as was shown in an earlier paragraph, the conflict is well-defined and divides participants into two more-or-less consolidated aggregates. Compromise has less chance to enter and influence the collective action process. However, in the mid-range the opposite seems to be true. Issues, leaders, group members, etc., become less clearly defined, and the conflict seems more unstable than for plans at the extremes. In the mid-range, the degree of cooperation exhibited has substantial influence on the receptivity of the arena; more plans succeed with a higher probability. Thus, unlike the stability which prevails at each end of the costs continuum, the mid-range conflict seems very sensitive to behavioral factors.

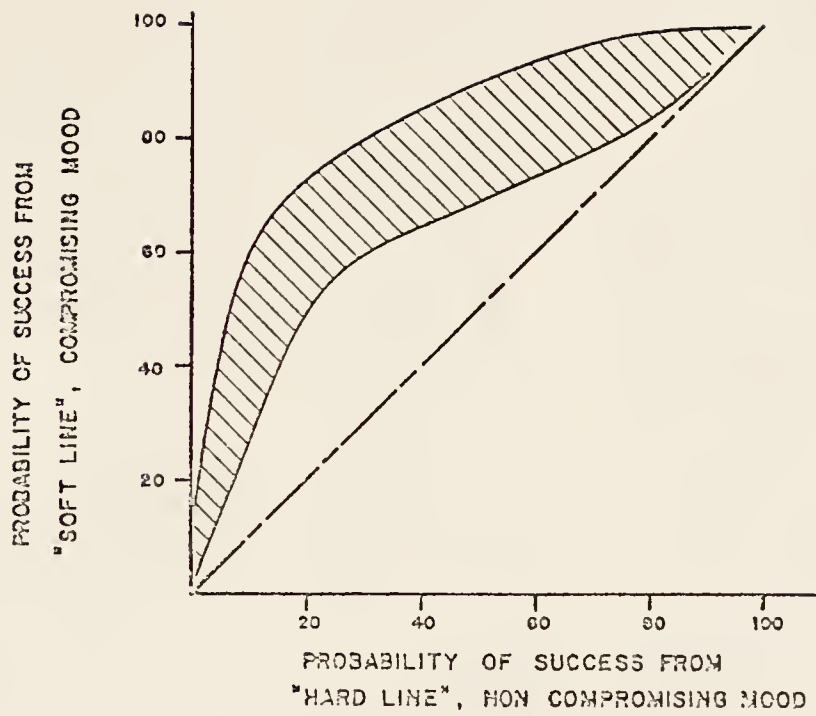


Figure 5.8. Arena Response to Changes in Cooperative Atmospheres

Thus an understanding of these phenomena would be a requisite of continued collective action analyses. Also, this diagram gives the analytical team a better feel for the desirability of addressing directly the nature of interpersonal relations which prevail in the local integrative problem. For instance, the planning agency may be pondering a suggestion to initiate a public relations program of one type or another. Is this undertaking worthwhile? It may be difficult to answer this particular question, however, it is clear that anything which changes the behavioral climate will affect the types of plans which emerge. Thus, the program will likely have an effect, but whether it is worthwhile or not is another question. A similar question can be asked about the desirability of initiating actual face-to-face interactive sessions with local participants. Small group research has much to say about this type of undertaking (see page 234); for instance, more intimate group relationships tend to increase cooperative spirit. This again would reflect itself in the arena output and would be of concern to the analytical team.

Another behavioral feature can be described as the ability of local actors to mold themselves into consolidated coalitions. This might range from a condition in which communication is very low and people cannot easily work together, to one in which face-to-face actions are required and coalitions cannot be easily avoided. The effect of such conditions on the arena response may be of interest to the analytical team because (1) each different locality will very likely exhibit its own degree of communication and (2) the team may wish to introduce different possibilities for coalition behavior into

the local situation. In terms of CASM, this behavioral factor can be introduced by changing the levels of ideological conflict required to disrupt the solidification of coalitions. In the case where coalitions are fragile and difficult to hold together, a "one-way conflict," defined as conflict *either* between leader and member *or* member and leader, was sufficient to produce a drop-out. Requiring a "two-way conflict," that is, simultaneous conflict between leader and member *and* member and leader, made coalitions more difficult to break apart. Finally, one can prohibit drop-outs altogether using a "no conflict" procedure.

The effect of changing the propensity of participants to form solid aggregates can be seen in Figure 5.9. Two-way conflict and no conflict situations produce similar results (considering variations due to randomness in the model). One-way conflict induces more fragile coalitions and thus makes it more difficult to unify a winning coalition. Under one-way circumstances it is more difficult to propose winning plans throughout the range of regional costs. More groups have a tendency to go their own way and concerted efforts do not materialize easily. This figure suggests that defining communication networks and making people aware of all the central issues would tend to focus participants into more explicit coalition efforts. Structured conflict of this type, one in which actors are encouraged to look for common ground and those places where all can gain through cooperative effort, was identified on page 160 as the primary objective of arena operation.

Figure 5.9 also shows the effect of including in the conflict an array of crosscutting issues. A "kink" in each curve can be observed

PLAN NUMBER	ONE-WAY CONFLICT			TWO-WAY CONFLICT			NO CONFLICT		
	Prob. Accept.	Power "yes"	"no"	Prob. Accept.	Power "yes"	"no"	Prob. Accept.	Power "yes"	"no"
12	0	.286	.605	0	.377	.605	0	.378	.622
23	17	.341	.461	45	.471	.487	34	.497	.503
28	70	.371	.288	100	.609	.314	100	.668	.332
48	70	.402	.306	81	.500	.353	78	.570	.430
63	100	.523	.197	98	.594	.310	100	.675	.325

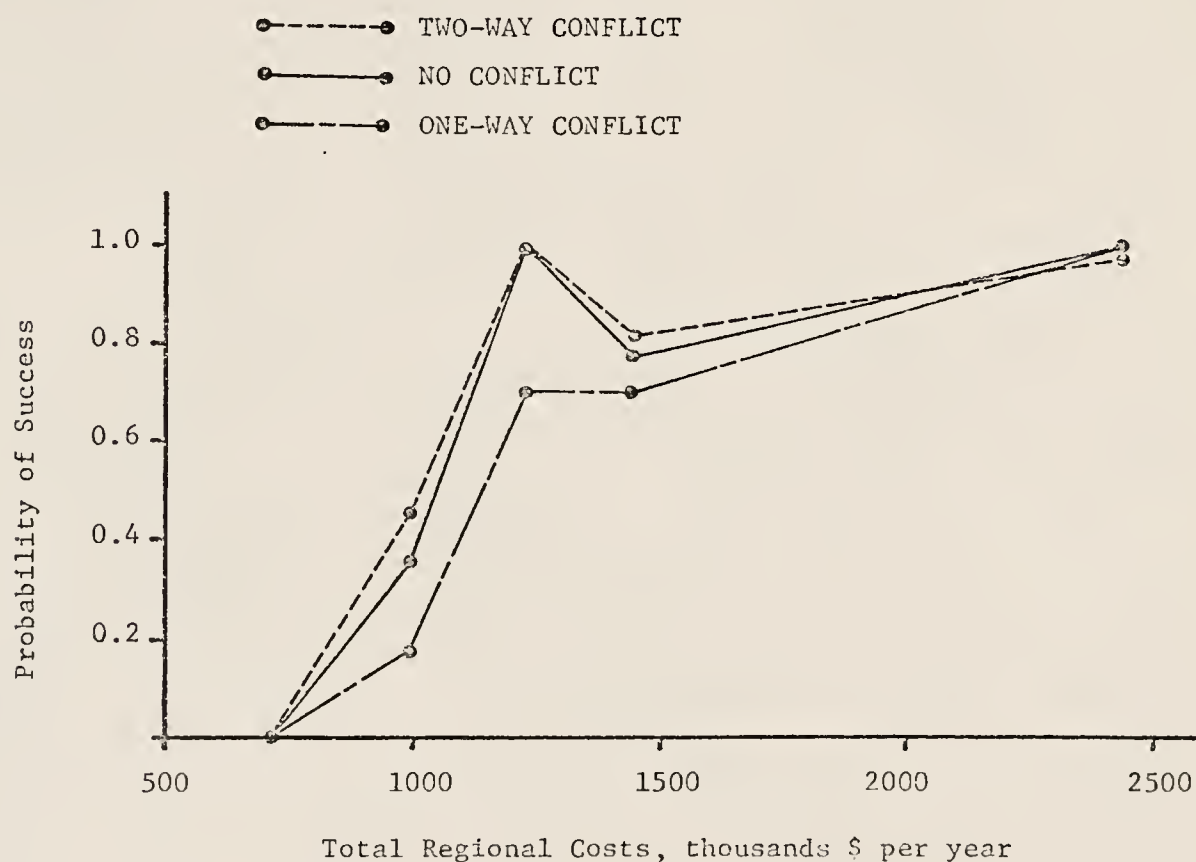


Figure 5.9. Influence of the Ability to Consolidate Coalition Effort

for a cost value around 1200. Considering the singular cost dimension by itself, it would be reasonable to expect a more uniform arena response. However, other issues come into play and distort the results one would get by considering a single component. In this instance, the stream classification takes an abrupt jump from a lower to a higher value. Although local people are interested in small incremental changes in stream quality and associated costs, certain extra-local interests concern themselves mainly with overall stream classes and are indifferent to the quality levels which may exist within a given class. Thus, when classifications change abruptly (this may mean only a change from 3.49 to 3.51 ppm of D.O.), certain groups fling themselves just as abruptly to other sides of the conflict. Such findings as these provide a caution light to warn the analytical team not to focus their attention entirely on a single issue, such as costs.

Quite often, crosscutting issues, those with substantial impact on local water problems, can be classified into the group called "intangibles." As a rudimentary definition, this class contains those issues to which monetary values cannot be readily assigned. Consequently, the explicit inclusion of intangibles has in the past been ignored or considered only as a final weighting in the decision process. Coomber and Biswas [1973] review several contemporary approaches for assigning monetary and nonmonetary values to intangibles. These methods primarily relegate the responsibility to the deliberations of a planner or analytical team. However, Gilbert White [1966, p. 111] describes correctly the social content of an evaluation of environmental factors, "It is important to remember that what commonly is called natural

environment has *meaning solely* [emphasis added] in a social setting in which the preferences are those of man interacting with man and nature." Burke *et al.* [1972a] extend the spirit of White's observations by recommending the collective action environment as the appropriate context for the evaluation of intangibles. Underlying this proposal is the notion that a value can be imputed to intangibles by means of the intensity of interactions or the willingness-to-act on the part of affected actors to push through or to defeat "intangible" issues. CASM, as an example device, permits the analyst to observe the collective actions and interactions which surround various project intangibles. Other models surveyed in Chapter IV could provide the same function, and so the collective interaction analysis should not be limited to CASM, of course.

Figure 5.10 employs a single project intangible, average stream D.O., and displays the arena response in an effort to assess the value which the social unit assigns to such an intangible. Behavioral assumptions are one-way conflict, soft line, and the plurality of power decision rule. Given these circumstances, the collective action environment in Bow Valley places high value on higher D.O. levels. (The shaded band is defined by the same 65 plans which served as the basis for Figure 5.8.) These results show that as D.O. increases the likelihood that the arena will accept a given plan also increases. Plans which fail to improve D.O. are defeated; plans which can produce higher D.O. levels receive more favorable responses. Considering all the factors which comprise CASM, it can be argued that the local social unit values higher D.O. levels more than lower. It can be further stated that

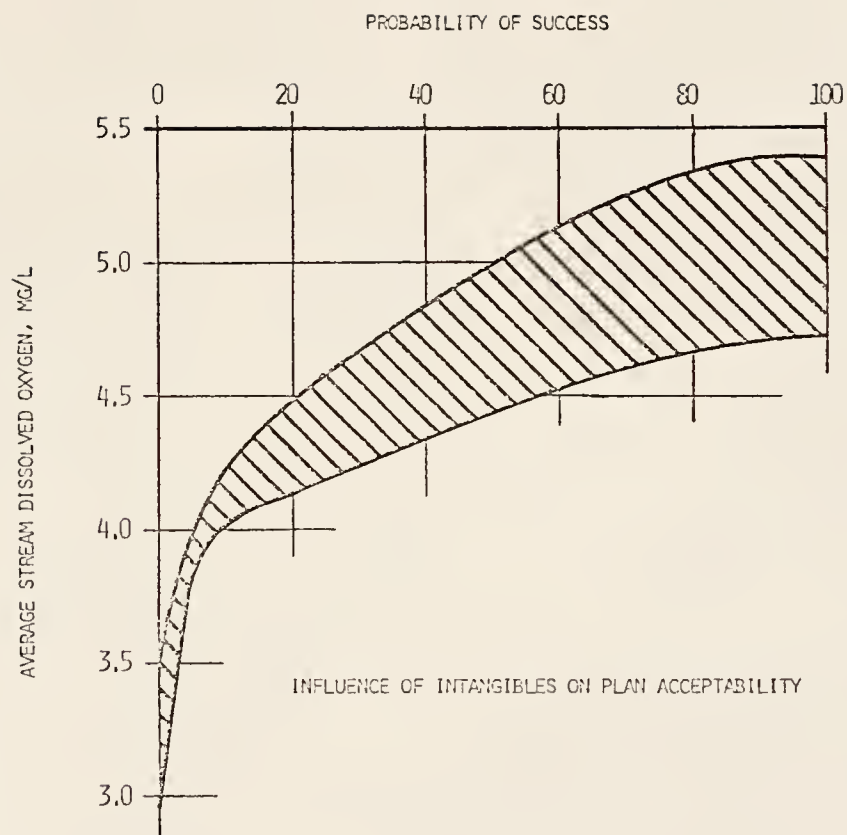


Figure 5.10. Arena Response to the Water Quality Component

the probability of acceptance begins to assign quantitative properties to this "valuation." In fact, by means of their *willingness-to-act* the Bow Valley collective participants prefer plans which would produce average D.O. levels in excess of 4.5-5.0 ppm.

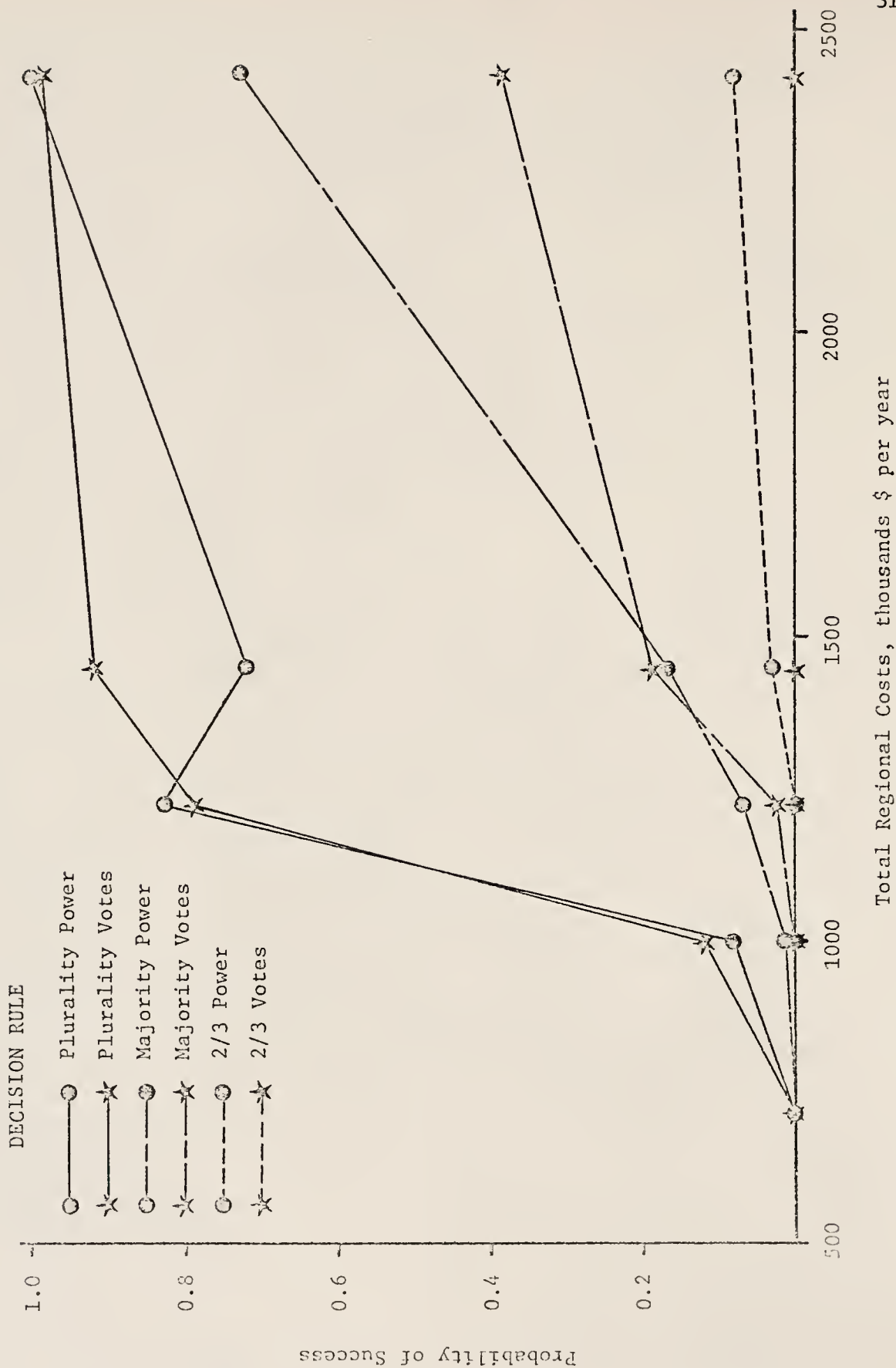
But, given these results, who stands to gain or lose from the Bow Valley conflict? Several times over it has been pointed out that *equitable, fair, and just proposals can be identified only in the context of the prevailing decision rule*. For Bow Valley, the original authors did not specify the decision rule to be followed, only that BVWPC would make the final recommendation. It was implied that information produced by the linear programming model would figure prominently in the Commission's deliberations, but the final rule was not specified. Without specific guides, one might envision a range of ultimate rules including the somewhat ill-defined interplays of power, bargaining and mutual accommodations, through very specific voting procedures.

CASM can begin to approximate this range of rules. Ill-defined interplays of power, which lead to final recommendations, enter through the summation of power coefficients for each member of a given coalition. A coalition can be declared the winner if it amasses a plurality of available power, a majority, or 2/3 of the total (as examples). More precisely defined voting procedures can be introduced as if each actor ($n=12$ here) were a member of an n -man commission. Again, one might be interested in voting rules ranging from plurality, to majority, through 2/3 vote. Unlike power interactions, voting procedures assign equal weight to each member of the commission. Previous models

have revealed, though, that this does not necessarily mean that each member has equal power even though each has only one vote.

The curves in Figure 5.11 begin to reveal the effects produced by alternative decision rules. Assumptions include soft lines positions and one-way conflict; the plans are those described in Table 5.2. Overall, it can still be said that the probability of acceptance increases as money spent increases, for all decision rules. In the Bow Valley situation then, there is a fundamental desire for improved water quality along with the requisite support to drive plans in that direction. But, to what level of waste treatment should the region be committed and to whom are various proposals fair and unfair? First, it seems that power and votes produce essentially the same curves under each rule, plurality, majority, and two-thirds. This can be attributed to the fact that the basic inventory of power revealed that power was more uniformly distributed over each participant than not. Thus, in Bow Valley one might expect similar results when considering power vs votes. Such would not be the case if only a few actors monopolized a majority of influence. Thus, the discussion here, for the sake of brevity, can be reduced to a consideration of plurality, majority, and two-thirds, disregarding whether power or votes are considered.

Plans are almost never accepted under two-thirds requirements. The Bow Valley conflict is too balanced to allow any side to develop a $2/3$ majority. Thus, if this degree of accord were required, few river basin plans would be put into effect. The winners, then would be those preferring the status quo; those who wished not to spend money for waste treatment and instead wished to take full advantage of Bow



Total Regional Costs, thousands \$ per year

Figure 5.11. Effect of Alternative Decision Rules

River's waste assimilative capacity. Also, reconsidering Figure 4.5 (p. 190), it can be said that a 2/3 majority places more importance on avoiding the railroading of plans over a participant's opposition and less importance on avoiding the voting down of an individual's favored proposal.

Majority requirements make it easier to approve plans which produce high water quality. The anti-pollution forces are now just strong enough to be able to amass a majority of power or votes and to push through the plans which they favor. Thus, this decision rule favors the conservation oriented participants and would systematically prevent other points of view from being heard. An entrenched majority would very likely be able to dominate the conflict over the long run making it difficult for the other side to maintain continuing interest and cooperative attitudes.

The requirement for a plurality produces strikingly different results. Now, those opposed to the entrenched majority can push through plans of their own, since they are able to amass a plurality by drawing upon middle-of-the-road participants for support. Although it is still impossible to push through plans with low cost and low water quality, the plurality rule does permit a much richer conflict and a much broader area for cooperative effort. Now, since a minority can actualize its preferences, even in the face of anti-pollution strength, it behooves the conservation forces to adopt a more cooperative stance. Thus, it can be argued that, given the full-range of Bow Valley circumstances, the BVWPC would see a more productive degree of participation if each actor was aware that a plurality of pressure

could swing recommendations in one direction or another. It would seem that conditions such as these would produce collective action judged as more just, equitable, and fair than stricter majority or two-thirds requirements. Furthermore, if BWPC adopted a mid-range plan, the decision rule corresponding to this suggests that they intend to weight their recommendation in favor of the minority positions, since the majority favors higher costs and water quality.

This analysis, including those in the preceding page, could be continued in greater detail following other lines of interest. However, the primary objective of this chapter has been to "test the waters," to see if the collective action approach could be implemented and if its results could be considered intelligible. Thus far, the answer to both questions has been shown to be affirmative. Another interesting question concerns the manner in which collective action analysis measures up against other approaches to the same problem. Fortunately, several other investigators have applied their own special techniques to Bow Valley providing, at least, a rudimentary set of results against which the collective action analysis can be judged. The section to follow briefly introduces and compares these approaches.

Bow Valley from Other Perspectives

The water quality problem is a comparatively new one when considering the total spectrum of water resource management concerns. It assumed this status, as a unique problem class, when it was realized that the assimilative capacity of any watercourse is a limited collective

resource that should be parceled out in some reasoned manner. Moreover, the parameters of water flow and water quality can be captured in reasonably simple mathematical expressions which opens the door for applications of a wide variety of quantitative analytical techniques.

One philosophy in particular pervaded early efforts to address the water quality problem. Given a water course with limited assimilative capacity and with numerous point sources of waste discharge, the percent treatment should be adjusted up or down at each source until assimilative capacity is consumed in some desirable pattern. The Bow Valley problem, and all attempts to analyze it, represent this approach to water quality deliberations. However, with the passage of time this approach has come to be regarded as impractical in real-world contexts. Without further elaboration, the effort to find and implement such a "finely tuned" set of treatment levels is overwhelmed by both technical and social difficulties. Thus, the Bow Valley problem as posed by its original creators must be considered unrepresentative of contemporary approaches to manage river basin water quality. Its redeeming virtue lies in the fact that it contains many of the essential features, both technical and social, held in common by most water management problems, and it is amenable to analysis by a diversity of techniques.

Dorfman and Jacoby [1969, 1971]

The original authors use a somewhat simplified but still standard approach as the basis for their analysis of Bow Valley (see Appendix A). They next extend the standard analysis, for their purposes, by adopting the following objective function:

$$\text{Maximize} \quad z = \sum_i w_i \text{NB}_i$$

where w_i = weight assigned to participant i

NB_i = net benefits accruing to participant i

$i = 1$, Cannery

$i = 2$, Bowville

$i = 3$, Plympton

$i = 4$, WQO .

In words, they seek to maximize the sum of net benefits to these four participants with the option of being able to investigate alternative weighting schemes. Thus, in addition to studying the classical "aggregate" problem (sum of benefits to whomsoever they accrue), by including weights they now have the option to investigate alternate distribution profiles, i.e., the "disaggregate" problem. Continuing in this spirit, the authors solve the basic problem numerous times, each time with a different set of weights. Every solution under this procedure describes a plan, three treatment levels, which generates a profile of consequences corresponding to the prespecified weights. By including a reasonable range of weighting schemes, the authors map out solutions which affect different participants in a variety of ways.

Given this information, it is possible for the analyst to step back and assume the role of BWPC who must commit the valley to a single course of action. The Commission must study subjectively the plans in terms of who loses and who gains, how well a given plan improves water quality, how closely a given weight scheme conforms to the perceived distribution of influence, and so on. Attempting to be

fair to all concerned and using the basic information, BVWPC recommends a first and second choice of plans:

RECOMMENDED PLANS (Dorfman and Jacoby)	WASTE TREATMENT LEVELS		
	Cannery	Bowville	Plympton
First Choice	90	80	55
Second Choice	90	66	61

These two plans can also be described by the set of social indicators in the same way that all plans were scaled for input to CASM:

PLAN	SOCIAL INDICATOR									
	1	2	3	4	5	6	7	8	9	10
1st	0.37	0.34	0.17	0.19	0.75	0.67	0.60	0.61	0.47	0.50
2nd	0.37	0.19	0.16	0.18	0.75	0.53	0.50	0.78	0.32	0.13

Then, submitting these plans to CASM using soft line, one-way conflict, and plurality of power, their first choice met with a 52% chance of success, the second choice succeeded with 0% probability.

What does this low level of acceptability mean? To begin, BVWPC turned to the linear programming model as a source of basic information. Thus, the fundamental model of planning behavior inherent in this "standard" or "classical" approach to the water quality problem also became the model of planning behavior assumed by BVWPC, although subliminally. On page 116 and again on pages 122 and 130-131, it was shown how one's underlying model of planning behavior determines what

is considered important and conversely what is considered less important. Using their LP model, the BVWPC (the original authors) consider explicitly only those participants for which consequences could be quantified and fed into the computer. This gives great weight and visibility to the Cannery, Bowville, Plympton, and WQO. All solutions revolve around these actors because the underlying model permits easy access, to the planner's cognition, only to these four groups. All other considerations are relegated to after-the-fact analyses, given this set of predetermined plans.

But, CASM reveals that by considering the larger system, the recommended plans meet with, at best, only limited approval. The collective action approach gives visibility and access to that broader range of factors which are known to be important to water resource management. Those factors which would have flowed into the Dorfman and Jacoby analysis after-the-fact can through the collective action approach be given visibility and can be elevated in status from the beginning of the analysis. Another observation serves to illustrate this point. The original authors were very sensitive to extra-model factors and devoted a great deal of space to their analysis, after the 1st and 2nd choices put forward. Thus, it would be irresponsible to suggest that they were unaware of important forces in the social decision trajectory. But, by their own admission they had to ignore those very features of the collective action envelope which ultimately reduced their recommendation to low levels of acceptability [Dorfman and Jacoby, 1971, p. 225]. Thus, it was the underlying model of planning behavior, not the sensitivity of the authors in question, which

distorted the analysis. Furthermore, their study brought forward much valuable information which if placed in a more meaningful planning context could have encouraged recommendations more closely in harmony with the total water management system. Thus, my remarks do not attack the validity of the original results as much as they emphasize the need for expanded models of planning behavior typified by the collective action approach.

Edwin T. Haefele [1971a]

Although they did not explicitly consider interpersonal interactions, Dorfman and Jacoby did suggest strongly the results one might expect under such circumstances. They accomplished this by introducing a vector of weights w_i into each plan so that the resulting scheme of treatment levels would benefit the participants in the same ratio as the prevailing weights. One might carry this reasoning further, according to the authors, by arguing that the relative proportion of benefits generated by each plan also corresponds to the real-world distribution of power among the participants. Since each actor will most likely be able to secure a share of the rewards proportional his power, so Dorfman and Jacoby reason, then the preassigned weights can be called "political" weights.

Haefele takes exception to this declaration that the w_i are "political" weights, although he has no quarrel with their procedure for investigating the distributive question by weighting benefits. Furthermore, Haefele contends (as does the collective action approach) that the key questions in public decisions revolve around the *process*

of interpersonal interactions and the manner in which actors might bargain or trade votes to arrive at agreeable solutions. It is not crucial to the logic here, but he also contends that vote trading activities will lead a collectivity more directly to solutions that one may describe as "socially optimal."

Thus, Haefele applied to Bow Valley his model of vote trading described previously on pages 198-201. This represents an explicit although limited introduction of collective action into the water quality problem. The plan recommended by his analysis was the same plan recommended by Dorfman and Jacoby. However, Haefele accepted as given the original set of solutions and considered only four participants, the Cannery, Bowville, Plympton, and WQO. Thus, his results give support to the original study (which has never been in question as far as it went). It represents an improvement, though, by introducing collective action as an explicit consideration. The more detailed comments provided above with reference to the original study also apply here.

Douglas A. Haith [1971]

Haith, as well as the two previous investigators, demonstrates a sensitivity to the social decision envelope and the fact that planning activities must begin to conform to its requirements. His approach, though, like most before him, avoids direct confrontation with sociological principles and stays within the confines of mathematical models with precise axiomatic or logical foundations. More specifically, he employs a variation of so-called decision analysis, statistical decision theory, or Bayesian decision analysis. These techniques are more fully

described by Pratt *et al.* [1965], Raiffa [1968], Hadley [1967]. and Schlaifer [1967]. In brief, these approaches are normative in character and attempt to identify preferred courses of action given individual preference structures and the high degree of subjectivity and uncertainty associated with them.

He selected three specific Bow Valley plans for analysis, ones which very closely resemble plans number 17, 32, and 40 of this study:

PLAN NUMBER	TREATMENT LEVELS		
	Cannery	Bowville	Plympton
17	90	60	80
32	90	80	80
40	95	88	56

Then, applying his procedure, Haith was able to identify the probabilities with which local participants would vote for each plan, under two conditions (1) where each considers factors of immediate concern to himself only and (2) where each considers the tradeoffs required to encourage concessions and bargaining with others:

PARTICIPANT	CHOICE PROBABILITIES					
	PLAN NO. 17		PLAN NO. 32		PLAN NO. 40	
	Before	After	Before	After	Before	After
Cannery	0.00	0.00	1.00	0.92	0.00	0.08
Bowville	0.50	0.25	0.46	0.46	0.04	0.29
Plympton	0.00	0.00	0.00	0.38	1.00	0.62
WQO	0.39	0.39	0.48	0.48	0.13	0.13
CASM Prob. of Success	0.07		0.62		0.93	

Included in the above listing are the probabilities of success from CASM for the same three plans. Since both Haith and myself had to generate independently the preference structures for each participant, it would not be appropriate to compare results with too much enthusiasm. However, certain interesting points can be noted. First, he considered only four participants from the array of actors which figure substantially in the decision process. As a group, and there are certain decisional similarities among them, they seem to prefer plan number 32. But, by ignoring other participants, he also does not uncover the fact that environmental forces will tend to drive plans higher, number 40 has a 93 percent chance of success, than waste dischargers alone would prefer. Unlike the Dorfman and Jacoby approach, though, Haith's method could more easily include a wider variety of groups and thus could address this problem more directly.

As was mentioned earlier, Haith does express personally an appreciation for the political climate in which planning must function; however, his technique does not. The foundations for this decision analysis approach are the preference *structures* of each participant and no more. Thus, collective action must penetrate the analysis only after-the-fact and only at the fancy of the analyst. Interactions are presumed to take place in the mind of the omniscient Commission, and thus collective decision phenomena tend to be suppressed. This may account for the fact that his findings express voting tendencies of each actor and do not suggest how the decision unit might behave as an interacting collectivity. As a technique for organizing the preference information for each actor, this approach performs admirably.

It should not, however, be used to represent the controlling process of collective action, characteristic of water management problems.

David E. Monarchi [1972]

In Chapter IV a clear distinction was drawn between unitary and collective decision problems. It was further pointed out that many fundamental principles from unitary theories were also fundamental to collective circumstances; but, limited space prohibited an in-depth review. Monarchi applies such concepts to the Bow Valley problem. His technique, although not basically collective, does represent a unique application, in the context of public decision making, of heretofore unexplored decision principles. In his opinion, it is an attempt to introduce human elements peculiar to each decision problem [Monarchi *et al.*, 1973, p. 837].

To account for collective action he collapsed all group-related phenomena into a composite "big brother." All subsequent analyses take place within BB which permits the direct application of unitary decision principles. Without describing the details of the Monarchi algorithm, his basic assumptions will convey its essential "behavioral" flavoring:

- (1) Perception is influenced by the total set of elements in a situation and the environment in which the situation is embedded;
- (2) Individual preference functions *cannot* be expressed analytically;
- (3) Value structures change over time;
- (4) Aspirations change as a result of learning;
- (5) The number of goals is usually less than seven;

- (6) The decision maker normally satisfices rather than optimizes;
- (7) A solution is any acceptable course of action; and
- (8) Acceptability is a learned perception.

Given these basic assumptions, BB proceeds through a series of iterative evaluations each time adjusting his goals and aspiration levels until he locates a solution which seems to balance the effective discrepancies between his expectations and that which he is capable of achieving. Such a brief description does not convey the reasoned and systematic procedure used to accomplish this task. The author should be consulted for additional details.

The listing below describes Monarchi's recommended plan for Bow Valley along with CASM plan number 52 which is quite similar to his. Treatment levels for his plan are somewhat high considering results from the other investigators. Also, CASM predicted an arena response of 96 percent acceptability which suggests that plans with lower treatment requirements would likewise produce satisfactory acceptance.

PLAN	TREATMENT LEVELS		
	Cannery	Bowville	Plympton
Monarchi Plan	88	87	82
CASM Plan 52	90	89	81

Thus, Monarchi's approach seems to point to an upper limit for recommended plans where Dorfman and Jacoby, and Haith specify solutions at the lower end of the water quality continuum. It would be inappropriate to carry these types of comparisons any further since each

author created his own preference structures for the groups involved. However, the contrast in styles gives a good feel for the range of methodologies available, the weak spots in each, and the manner in which contrasting approaches can complement each other.

Findings from This Initial Exploration

The primary objective of this chapter has been to explore a controlled water resource problem environment guided by the set of organizing statements now called the collective action approach. As subobjectives, it was also intended to use the Bow Valley problem as a vehicle for (1) illustrating the step-by-step logic inherent in collective action analysis and for (2) comparing this procedure to other independent studies in the same river basin.

Although rough edges appeared in the translation of principles from Chapters II, III, IV to a realistic problem, it was shown that this framework could impart a useful degree of organization to an analysis of the larger Bow Valley problem. The incremental application of first the General Theory of Action then collective action analysis revealed quite clearly where pieces of the puzzle were missing and suggested how the gaps might be filled. Moreover, it served as a device for organizing the multitude of complex factors which usually must be sidestepped in more traditional studies.

Thus, the entire collective action approach can be implemented, and it can generate results which are intelligible and sensible. Whether such results will become a decisive ingredient in day-to-day

water-related decisions is a larger question which can be answered only through the test of time. However, at a higher level of generality, there can be no doubt that such an approach must become more firmly established as a guiding mechanism in overall planning behavior.

On a more practical level, the collective action approach compares well with other prominent techniques in the water resource management field. It is no harder to apply and it produces results just as readily. With regard to Bow Valley in particular, no one can say which set of plans are better since each procedure seems to focus on somewhat different solutions. However, if one feels that solutions are inherently sounder if they face the test of a larger number of important variables, then the collective action approach must be considered more encompassing, more revealing, and more appropriate than other available methods.

CHAPTER VI

EXPLORATION OF A REAL-WORLD ENVIRONMENT

. . . those who take a flying leap toward more ambitious targets are bound to leave portions of their intellectual anatomy exposed or awkwardly posed.

--Richard C. Snyder [1958, p. 3]

A Prolegomena

It is now time to extend the guiding principles from Chapters II, III, and IV and the testing experience from Chapter V to a real-world water resource management problem. The Upper St. Johns River Basin, Florida, provides the issues into which this initial exploration can be made. Figure 6.1 contains a map describing its general location.

Most water resource problems have historicity; they evolve and mature over many years and phases and as a result must be studied in the context of past events. The Upper St. Johns (hereafter called the St. Johns) trajectory began in the early 1800s as settlers recognized its vast agricultural potential. For many decades thereafter, agriculture dominated man's activities as more and more land fell under the influence of private diking, drainage, and other water control efforts. More recently, urbanization has emerged to challenge agriculture for desirable St. Johns land to the extent that these two activities now clash in the competition for available land and water.

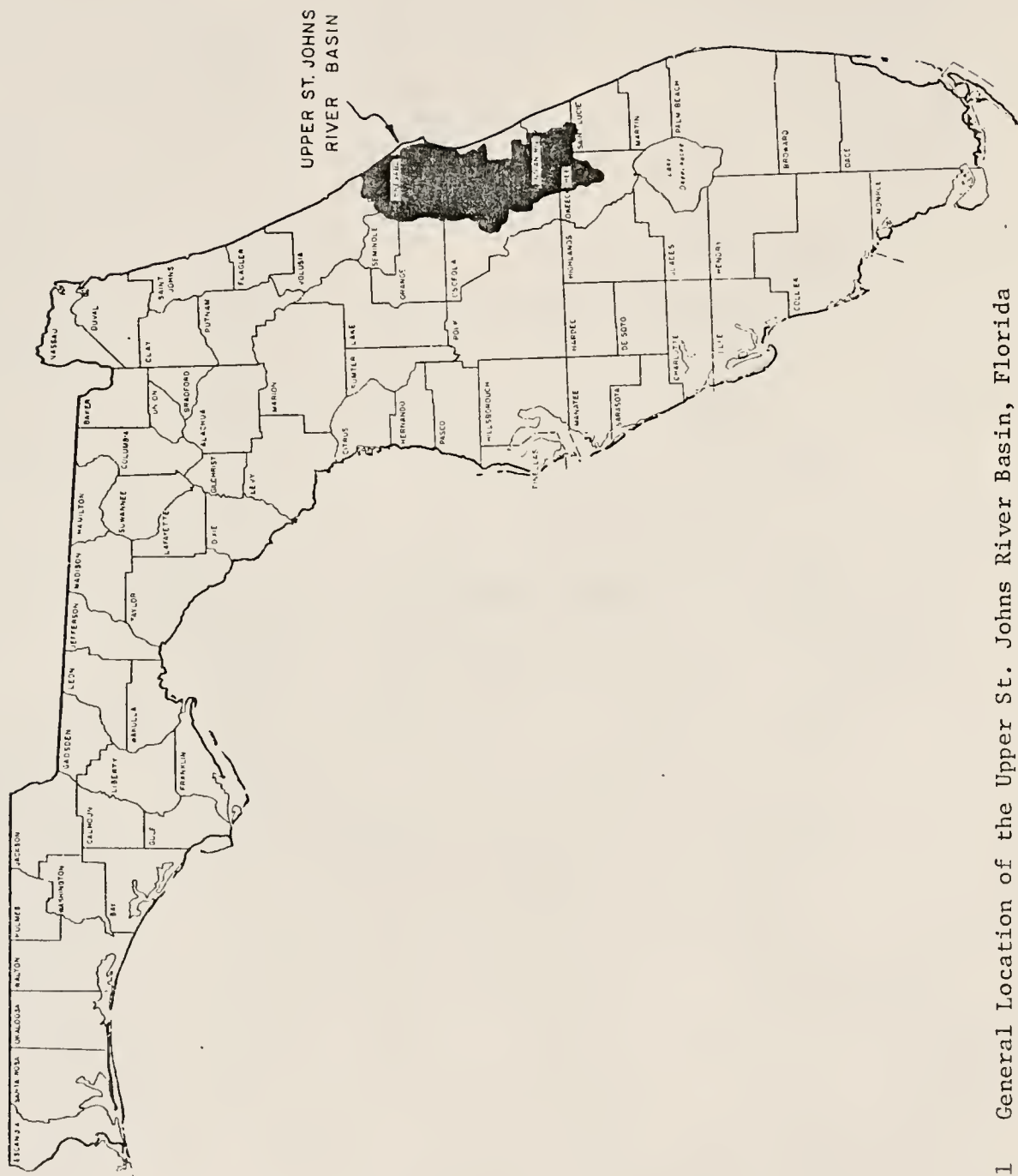


Figure 6.1 General Location of the Upper St. Johns River Basin, Florida

During this process of gradual encroachment into the St. Johns, numerous organizations formed to deal with the various problems associated with these expanded activities. Since overall coordination of these organizations has been virtually nonexistent, there now exist at least 8 local organizations, 2 regional authorities, 12 state agencies, and an equal number of federal agencies with a tangible stake in the water resource of this area [Florida Department of Natural Resources, 1970].

In this short chapter, it would be nearly impossible to sort out the areas of responsibility for each organization and to weave into that examination the complex maze of local, state, and federal laws which also apply. However, for the sake of this chapter, it is safe to identify as dominant water-related organizations, the U.S. Army Corps of Engineers (COE), the Central and Southern Florida Flood Control District (FCD), the Soil Conservation Service (SCS), and more recently the U.S. Environmental Protection Agency (EPA), and the Florida Department of Pollution Control (DPC).

Prior to World War II, the primary water management activities in the basin consisted of privately owned water control facilities in conjunction with local drainage districts. However, the now legendary floods in the late 1940s revealed a need for more comprehensive management programs to mitigate the cumulative effects of man's gradual encroachment. Enter then, the large construction agencies COE, FCD, and SCS who began to prepare the details of large scale projects for the management of St. Johns water resources.

An initial plan in 1949 sponsored by COE and FCD primarily served the purpose of flood control by proposing diversion canals to

carry excess water from the main stem of the St. Johns directly to the Indian River, and thereby to the ocean. Possible damage to the Indian River estuary and a benefit cost ratio below 1.0 led to the rejection of this proposal.

In 1957, the Corps of Engineers proposed a "storage and floodway" plan as described in their *General Design Memorandum*. This plan would have established two large conservation areas along the main stem of the St. Johns river using 115 miles of dikes and levees. FCD objected to this proposal because it required the purchase of too much land and did not protect the interior upland areas from flooding.

In the meantime, pressures for municipal water supply, urban development, and agricultural expansion encouraged a rethinking of project configurations. A new Corps proposal appeared in their *Addendum I* [1962] to the basic memorandum. The revised plan called for three interior upland reservoirs connected to smaller conservation areas along the main stem of the St. Johns River. Included in this package was a diversion canal in the southern part of the basin which could carry excess flood waters directly to the Indian River, if necessary.

At the time of proposal, this plan seemed acceptable to most of the interested parties except landowners around Lake Wilmington. Thus, in their *Addendum II* [1969] the Corps made minor changes to mollify these disgruntled citizens and thereby established the configuration of the project under consideration today.

With the plan essentially finalized, construction began in 1967; to date, facilities for the diversion canal and the interior

upland reservoirs have been completed. But, in the interim EPA, DPC, the Florida Game and Freshwater Fish Commission, along with the Audubon Society, Sierra Club, and other groups focused attention on potential environmental problems associated with this plans.

In March 1971, responding to these pressures, the Governor's Office halted construction until proper studies of the project and its potential impacts could be prepared. Complicating this situation, the Water Resources Act of 1972 created a new agency, the St. Johns River Basin Water Management District, whose powers and responsibilities are not clearly defined. Also, attention must be paid to other in-depth studies and project proposals for the St. Johns basin put forth by the Soil Conservation Service [*U.S. Department of Agriculture, 1969*]. It is presently unclear how their water control activities will relate to other efforts described above.

To recap, there now exists a partially constructed multipurpose project which has been stalled because of environmental concerns; there exists a newly-formed water management agency (one administrator and one secretary) with ill-defined responsibilities; and there exists an SCS proposal for interlocking water control facilities which have not received environmental review.

Enter the Department of Environmental Engineering Sciences, contracted by the Corps of Engineers to perform *Socio-Economic Studies of the Upper St. Johns River Basin* [Heaney *et al.*, 1973]. In this complicated atmosphere, one might guess that this contract could be interpreted in various ways: for instance, the on-site engineer might expect a report containing a "go" or "no go" for construction facilities

described in the design memoranda; others might expect a more comprehensive, generalized water resource study with less emphasis on existing facilities, per se.

Such was the climate surrounding the St. Johns study. This particular chapter, however, narrows the focus and reports primarily on attempts to extend the collective action approach, as much as possible, into this maze of complexities, confusions, and uncertainties. Since the final St. Johns report and its supporting material fill many pages and volumes, it will not be possible to recreate the entire problem here. Instead, the sections to follow should be viewed as a companion document containing only a minimum of these basic descriptions. The final report [Heaney *et al.*, 1973], a master's thesis [McLaughlin, 1973], and several technical documents [U.S. Corps of Engineers, 1957, 1962, 1969; U.S. Department of Agriculture, 1969] describe more fully the associated details of the St. Johns problem.

The following diagrams, however, provide a general feel for the nature of the situation to be studied. An outline of the Upper St. Johns drainage area is shown in Figure 6.2, divided into 21 smaller hydrologic planning units. These subdivisions introduce a necessary amount of geographic disaggregation into the problem.

Privately-owned water control facilities over the years have expanded and squeezed the natural floodplain into a smaller, narrower area. Figure 6.3 contains an outline of existing dikes describing the extent to which man has encroached into virgin marshland.

Compare these existing diked areas to the natural floodplain outlined in Figure 6.4. This area has been defined as major land

resource area 156 (MLRA 156) by the Soil Conservation Service [1965]. By considering soil, vegetation, water, climate, and other factors, they defined this area as a single homogeneous land resource type, "Everglades and Associated Areas." It can be assumed that the virgin, natural floodplain is equivalent to MLRA 156.

The proposed Corps plan is outlined in Figure 6.5. Dikes and levees create three interior upland reservoirs, Jane Green, Blue Cypress, and Fort Drum, which catch flood drainage and store water for other uses in dry periods. These upland reservoirs are then connected to reservoirs, also formed by dikes and levees, along the main stem of the St. Johns river, Lake Poinsett, Lake Washington, and Lake Wilmington. The diversion structure (Sebastian Canal) from Lake Wilmington directly to the Indian River, and the ocean, is not shown. Considering these interlocking structures, it would be possible to intercept general water movement and then route collected water in almost any desired pattern.

Figure 6.6 contains some additional information for the St. Johns basin. Landowners whose holdings extend into the basin and add up to more than 5000 acres are identified along with the approximate boundaries of their properties. Presented in this way, the small number of landowners with large holdings emerges as the striking characteristic. A general breakdown of ownership statistics appears in the following listing.

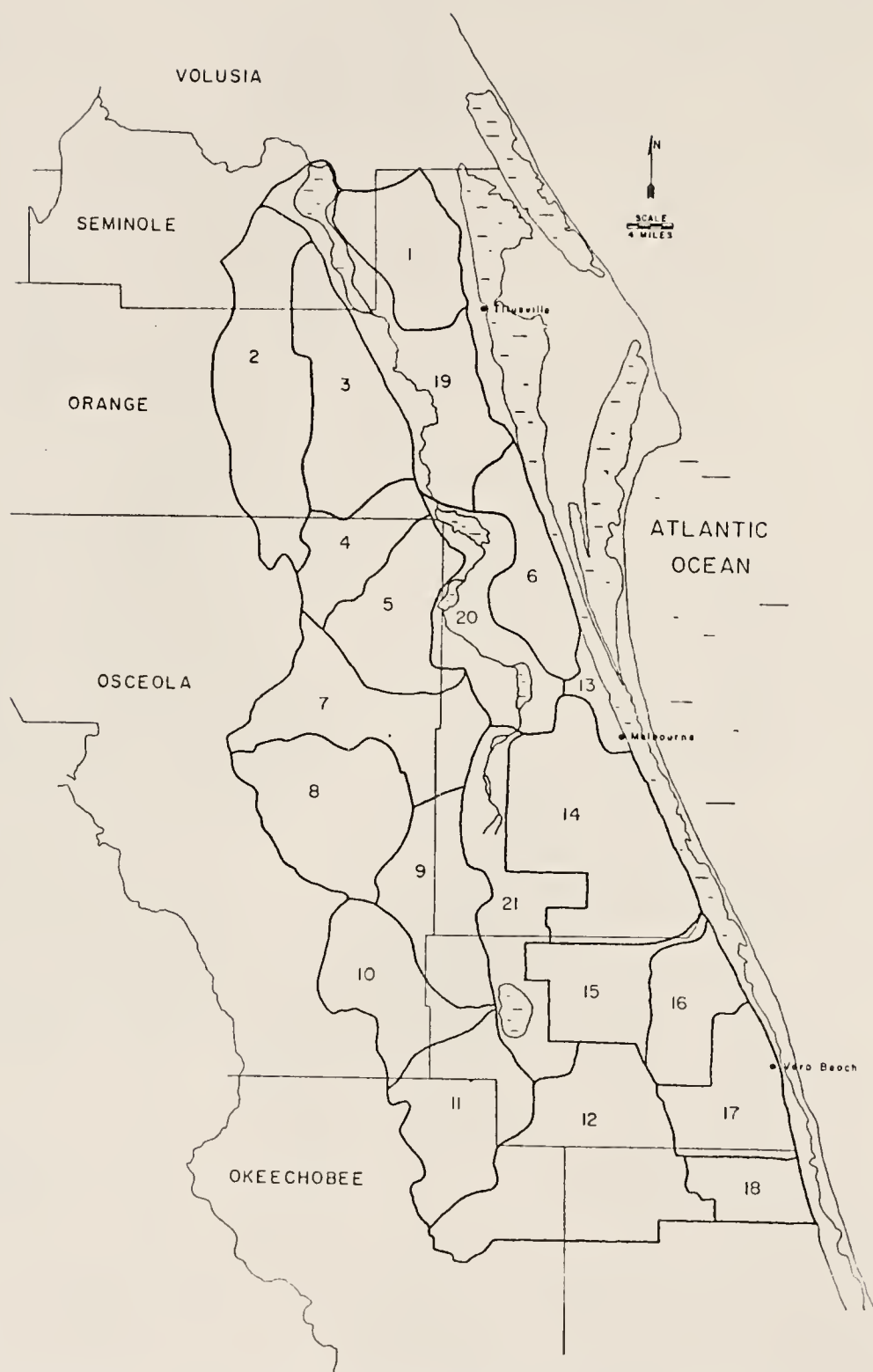


Figure 6.2 Outline of the Upper St. Johns Drainage Basin
Divided into 21 Hydrologic Sub-Basins

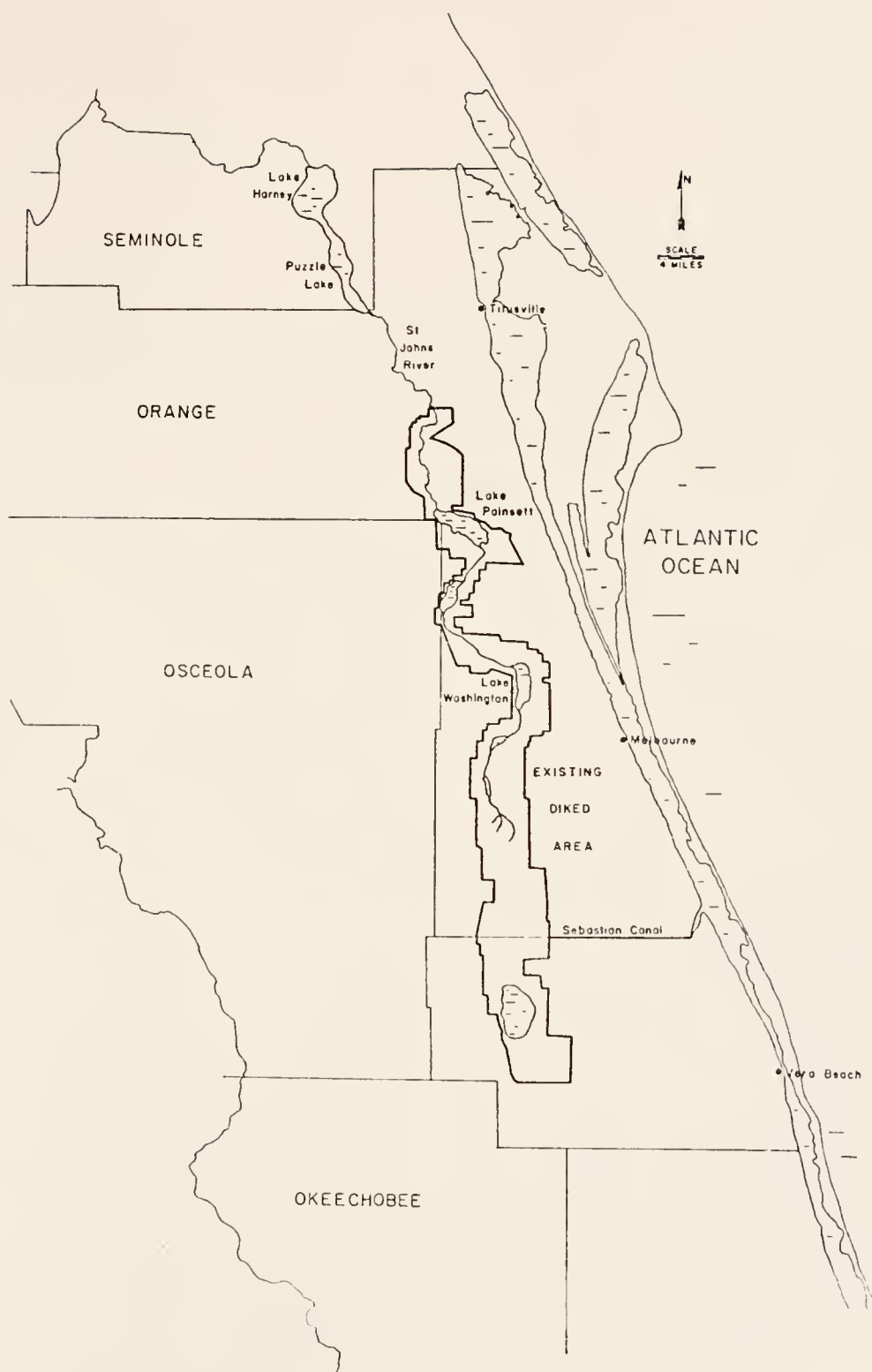


Figure 6.3 Outline of Existing Dikes Defining the Extent of Man's Encroachment into the Upper St. Johns Drainage Basin

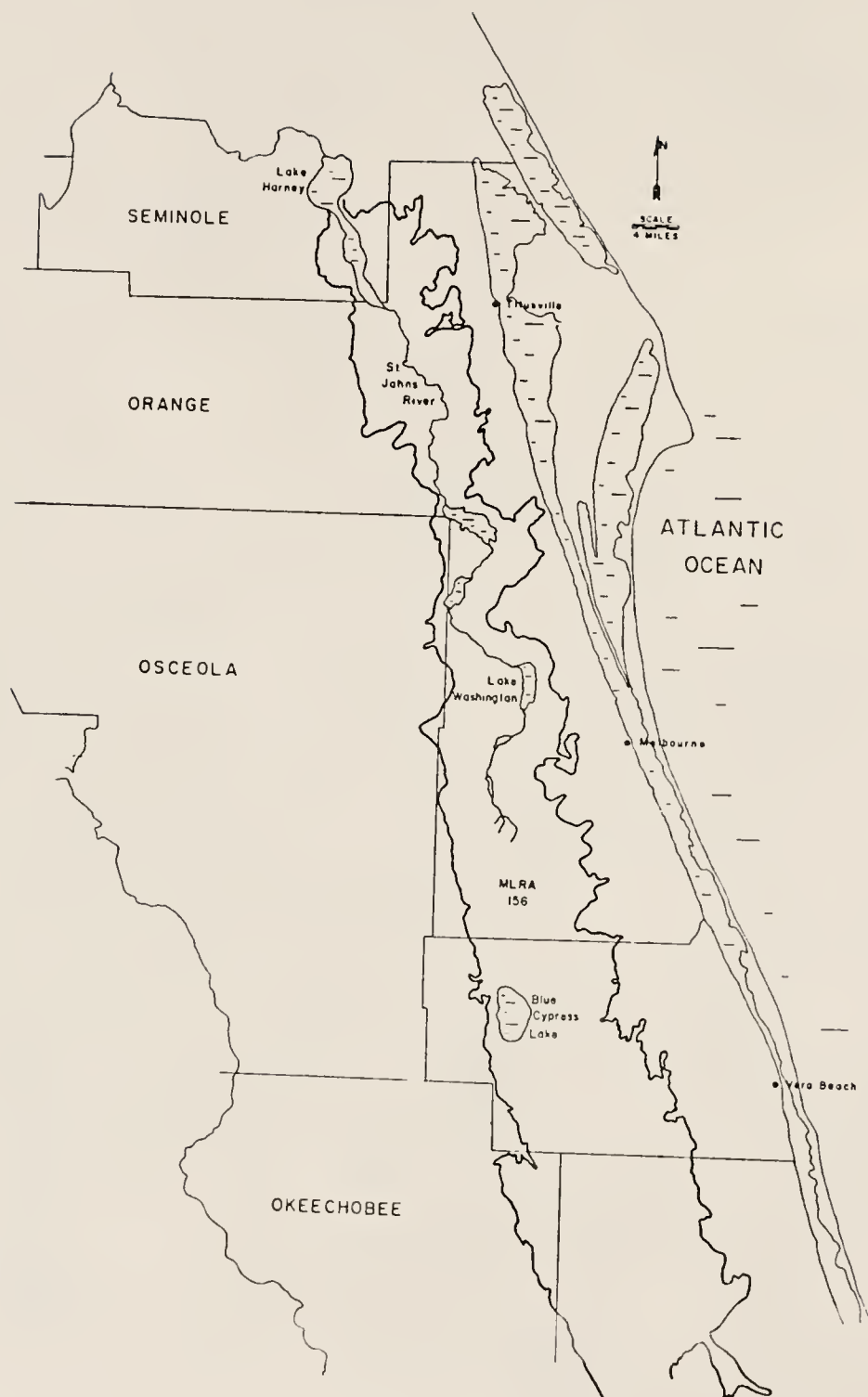


Figure 6.4 Outline of MLRA 156 Defining the Extent of the Natural, Virgin Floodplain in the Upper St. Johns Drainage Basin

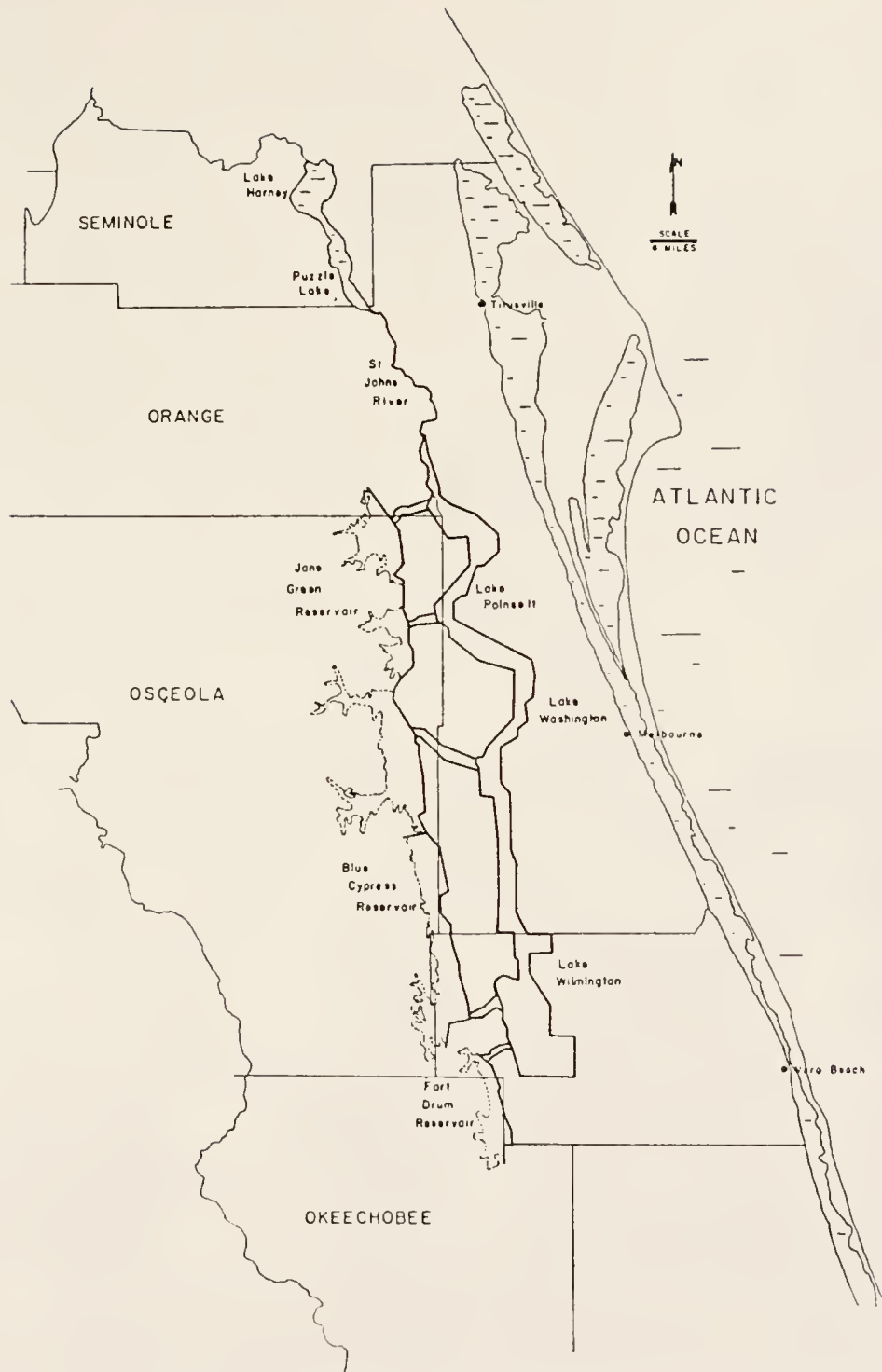


Figure 6.5 Schematic Diagram of the Proposed Corps Project for Water Control in the Upper St. Johns Drainage Basin

Size of Holding, Acres	Number of Owners	Percent of Basin
Greater than 50,000	3	18.9
25,000 to 50,000	5	11.3
10,000 to 25,000	15	15.7
5,000 to 10,000	18	7.6
Totals	41	53.5

Although the Corps' research contract expressed primary interest in an evaluation of the positive and negative effects of their authorized plan, it eventually became necessary to introduce additional alternatives for consideration: (1) to establish performance measures against which the Corps' proposal could be compared and (2) to encourage a broader perspective than would have been possible by studying the authorized plan alone. Table 6.1 contains a listing of the different alternatives considered. They break down into four main categories:

- (1) *Unrestricted encroachment plan*, let the historical pattern of development continue without intervention of public agencies. No further project construction;
- (2) *Proposed Corps project*, finish construction of the authorized Corps project described in their design memoranda;
- (3) *No further encroachment plan*, through zoning or other regulations prohibit further development of the natural flood plain beyond the existing diked areas; and
- (4) *Natural floodplain plan*, return the virgin floodplain MLRA 156 to its natural state.

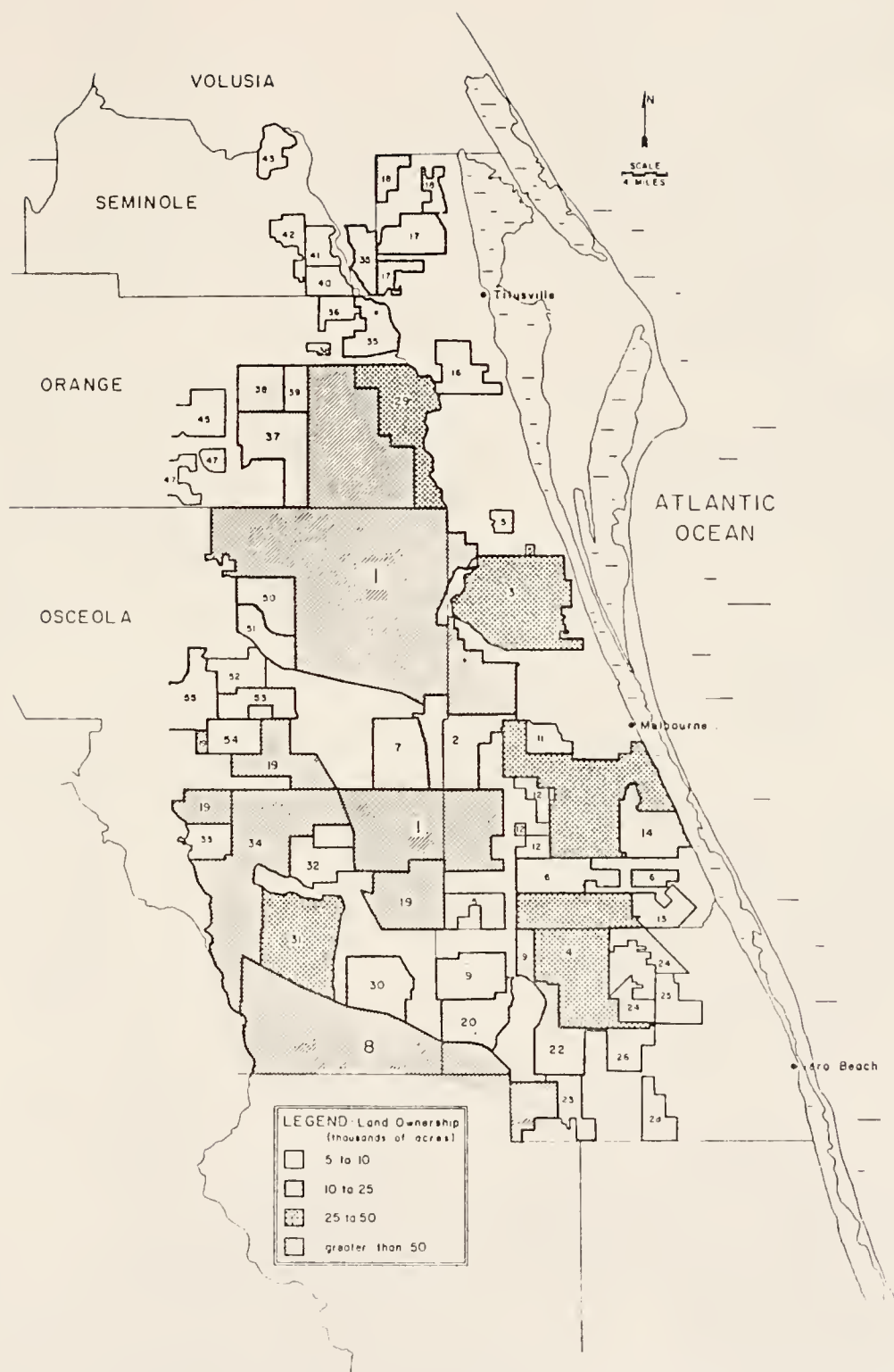


Figure 6.6 Property Outlines of Land Holdings, of More Than 5000 Acres, Which Extend into the Upper St. Johns Drainage Basin

TABLE 6.1 BRIEF DESCRIPTION OF ALTERNATIVE PLANS CONSIDERED
FOR THE UPPER ST. JOHNS RIVER BASIN

PLAN A: UNRESTRICTED ENCROACHMENT PLAN

- A1 Eliminate existing upland structures. Floodplain encroachment permitted at higher elevations in planning units 19, 20, and 21.
- A2 Eliminate existing upland structures. Floodplain encroachment permitted at lower elevations in planning units 19, 20, and 21.
- A3 Retain existing structures. Operate them as both flood control and water supply projects. No additional construction. Floodplain encroachment permitted at higher elevations in planning units 19, 20, and 21.
- A4 Retain existing structures. Operate them for flood control only. No additional construction. Floodplain encroachment permitted at higher elevations in planning units 19, 20, and 21.
- A5 Retain existing structures. Operate them as both flood control and water supply projects. No additional construction. Floodplain encroachment permitted at lower elevations in planning units 19, 20, and 21.
- A6 Retain existing structures. Operate them for flood control only. No additional construction. Floodplain encroachment permitted at lower elevations in planning units 19, 20, and 21.

PLAN B: PROPOSED CORPS OF ENGINEERS PROJECT

- B1 Construct project works as described in the authorized plan. Jane Green Reservoir used for flood control only, with complete drawdown capacity.
- B2 Construct project works as described in the authorized plan. Exclude municipal water supply.

PLAN C: NO FURTHER ENCROACHMENT PLAN

- C1 No development permitted in areas outlined in Figure 6.3. Retain existing upland structures. Operate them both for water supply and flood control.
- C2 No development permitted in areas outlined in Figure 6.3. Retain existing upland structures. Operate them for flood control only.

PLAN D: NATURAL, VIRGIN FLOODPLAIN PLAN

- D1 No development permitted in areas outlined in Figure 6.4. Retain existing upland structures. Operate them both for water supply and flood control.
- D2 No development permitted in areas outlined in Figure 6.4. Retain existing upland structures. Operate them for flood control only.

Introduction of Collective Action Analysis

Given the historicity of the St. Johns problem, the resulting climate surrounding the St. Johns study, descriptions of the study area, and proposed alternatives, it is possible now to extend concepts from this thesis. We can look to Chapter V for assistance in this undertaking. Since Bow Valley contained a well-defined, controlled problem environment, that basin was used to demonstrate the detailed step-by-step logic associated with a relatively complete collective action analysis.

Identification of Decision Participants

McLaughlin [1973] should be consulted for complete details on the identification and interviewing of visible decision participants. Within the previous survey of community decision models (pp. 228-235), three more-or-less standardized techniques for performing power and decision studies were outlined. Because of personnel and resource limitations, neither of these approaches was *strictly* followed. Instead, a more unstructured fast-and-loose procedure had to be used.

In brief, several central actors were first identified from a search of correspondence files in various agencies. These leads along with those provided by agency "knowledgeables" defined an initial set of likely candidates. Interviews with these likely candidates produced an expanded list of participants. By continuing to interview visible contenders, in a sequential manner, a basic set of commonly identified actors began to repeat itself. Without exploring further,

this set was assumed to contain the prominent decision participants. Although this procedure and its results cannot be compared rigorously to standardized techniques, few would argue against the basic set of actors identified: landowners, conservation organization, government agencies, elected officials, and certain local citizens.

Landowners. The major portion of the land in the Upper St. Johns basin is owned in large tracts. The principal uses are cattle ranching, citrus, and residential community development.

Cattle ranchers. In general, cattlemen appear to be opposed to the FCD plan of 1962. Their opposition appears to be based on a belief that benefits to them are small and inconvenience or direct financial loss have negated any possible benefit. The only reason some cattlemen would appear to support the project is altruistic concern for the area, or to prevent the conservationist from feeling he controls the basin.

Taxes are an issue that the cattleman refers to repeatedly. In return for his taxes, he appears to feel he is getting little. He does not feel the project is designed around him. He often cites the power of the environmentalists and the fact that land taken from him, by the FCD, is to be used for public recreation.

The cattleman tends to reduce the controversy to a matter of simple priorities. As a farmer, he refers to the basic needs of any human being--food, shelter, and clothing. Once a society can meet these basic needs, it can turn toward satisfying loftier goals. It is this philosophy that shapes the cattleman's attitude toward environment

in the Upper St. Johns. A clean and well protected environment is an admirable and desirable goal as he sees it. However, any steps toward environmental protection which make farming more difficult and/or economically infeasible, are a mistake.

The cattlemen contacted during this study expressed resentment at being stereotyped as unconcerned for the environment. Stemming from a life close to the land, they consider themselves to be the original conservationists. The farmer appears to feel that he has learned from first hand experience that man must respect nature or destroy the hand that feeds him.

The cattlemen appear to be virtually unanimous in feeling that they have little political influence in the Upper St. Johns. They seem to feel that conservationists, because of their ability to stir people's emotions, are the most powerful.

Citrus growers. Based primarily on irrigation benefits, the citrus interests of Indian River country appear to be in favor of the FCD plan. Other strong points of the project, as the citrus people view it, appear to be flood protection, better disposal of drainage water, and water supply for Melbourne.

The citrus growers have many of the same viewpoints as the cattlemen. The citrus people appear to feel that environmental conditions in the basin are not nearly as bad as conservationists would like the public to believe. Again, one finds the feeling among them that national priorities which place pollution control ahead of agricultural production are misplaced.

One noticeable difference between the cattleman and citrus growers is their attitude toward the FCD. The citrus people appear to feel that the FCD Plan is good for the area. The attitude of citrus people toward most of the other decision participants is similar to that of the cattlemen.

Land developers. The major urban development in the area is General Development Corporation's (GDC) Port Malabar. This community is located on a 42,000 acre tract located in the Melbourne-Tillman drainage district. This drainage district already drains to the Indian river, but impacts of Port Malabar are felt in the St. Johns basin.

GDC is, of course, primarily concerned with residential development. This appears to give them a bad name with many other actors who feel growth is bad for the area or dangerous to the environment. It appears that GDC stands to gain from completion of the reservoir project (Plan B). Flood control would increase the amount of land they could safely develop. Increased recreational opportunities would seem to make their land more attractive. Water supply, although not presently a problem since they go to deep wells, would seem to make an expanded population more feasible.

On the environmental issues, GCD seems to feel they side with the conservationist. This is a curious situation since the least likely group which the conservation community would consider to be an ally would probably be GDC. Again, it comes back to perception. The conservationists seem to feel any large scale residential development is environmentally unsafe. GDC maintains that they might even improve the quality of water discharged from their canals by in-stream aeration and other controls.

GDC does not appear to dislike any other group. They seem to feel that they have no reason to be in conflict with anyone. The broad question of population growth can possibly account for the fact that many other participants do not reciprocate with this type of attitude. Quite obviously, GDC must take the position that planned growth is good for the area.

Environmentally Oriented Agencies. These agencies include the Environmental Protection Agency and the Florida Game and Fresh Water Fish Commission. They appear to oppose the reservoir plan because they consider it environmentally unsound. Water quality appears to be the most important issue from this point of view, followed closely by marsh preservation and protection of fish and wildlife resources.

These agencies are generally opposed to impounding water. They feel that nutrients and pesticides from agricultural runoff would lead to eutrophication and that the project would take away the natural processes by which the marsh assimilates nutrient-rich runoff.

Water supply for Melbourne is another important issue to these agencies. The Florida Game and Fresh Water Fish Commission has been active among the forces who claim that water behind the Jane Green reservoir will be pumped to citrus growers and decrease both the quantity of water in Lake Washington.

In general, these agencies appear to view the landowners as the controlling interests in the basin. They seem to feel the project is designed around agriculture. These agencies appear to have good personal relationships with the Audubon Society, the Sierra Club, League

of Women Voters, and others who oppose the project. The FCD appears to have a bad name with these agencies.

Elected Officials. The degree to which politicians are interested in the Upper St. Johns is dependent upon the extent to which their constituency happens to be affected. County and local officials seem to be the ones most interested in the water-related issues.

Brevard county. The Brevard county commissioners appear to support the project. They seem to feel their first responsibility is to provide drinking water and that the FCD project is the best method of meeting this goal. Other advantages, as the county commissioners appear to view them, are flood protection and recreation.

A major concern of the county commissioners appears to be the Water Resources Act effective July 1, 1973. Under this act, the FCD will no longer have jurisdiction over the Upper St. Johns. The commissioners' concern is over whether Brevard county will be compensated for the taxes it has paid to the FCD for 25 years. The commissioners appear to feel that by completing this project the FCD will have given the people of Brevard county something for their money.

Environmental concerns are shared by the commissioners. However, they appear to feel conservationists are unreasonable and oppose desirable progress in the name of a clean environment. At the heart of this apparent conflict may be their attitude toward population growth. The commissioners do not appear to be opposed to an increase in the population of Brevard county.

Melbourne city council. There is a distinct split in this body over benefits of the project. Approximately three members seem to share the view of the Game and Fresh Water Fish Commission that the project would not solve water supply problems; approximately four councilmen appear to feel the project is the best way of insuring an adequate supply.

Although the water supply goal of all councilmen is the same, they disagree over the means. Perhaps more fundamental is a difference in long term goals and priorities. Those who oppose the project appear to be advocates of population control. Also, they appear to be concerned for the natural environment and those planning goals oriented toward "bigness." Those councilmen supporting the project do not appear to be worried about the impact of increased population on the south Brevard area.

Conservation Groups. The Audubon Society and Sierra Club are the most visible organized conservation groups. Basically the position of the conservationists is similar to the environmentally oriented agencies that oppose the project. The marsh area is the most important issue to these participants with water quality following in second place. Importance is attached to their role as spokesmen for the natural system. Conservationists appear to feel they are in a position to exert considerable influence on the planning agencies.

Citizens in the Melbourne Area. Because the project directly affects their water supply, emotionalism runs high among the Melbourne

citizens. Again, they do not conflict over the immediate objective, only over the means of realizing it.

Opposition forces. Opposition from the private sector seems to be led by the League of Women Voters. The League works closely with the Audubon Society and Sierra Club and is conservation oriented. The League is very interested in public participation programs. Much of their opposition may be based on what they perceive to be a lack of opportunities for public involvement.

Supporting forces. Local support comes from concerned citizens who feel the FCD project is the best way to meet water needs. These people feel that environmental concerns are all well and good but are over dramatized and insignificant in relation to domestic water supply.

These citizens do not appear to have strong feelings over issues other than water supply. Flood control is typically thought to be one important benefit of the project. Population growth appears to be viewed as inevitable and provisions should be made now for supplying water for an increased population.

Flood Control District and Corps of Engineers. Although existing as two separate entities, it is quite difficult to draw clear lines between their areas of responsibility or to figure out what position each occupies in the St. Johns pecking order. Often their activities and positions coincide; just as often the reverse is true.

Flood Control District. In the not-too-distant future, FCD will no longer have direct responsibility in St. Johns affairs. However, because of a long history of involvement it will be difficult for them

to pull out, at least in the minds of involved participants. Since FCD is not primarily an engineering design and construction agency, they express a genuine willingness to incorporate all points of view into their deliberations. But, their historical single mission, flood control, and their close relations with traditional water resource planning agencies reduce the FCD's credibility in the eyes of many decision participants.

Corps of Engineers. COE is primarily a design and construction agency, and as a result, has a tangible stake in programs which include facilities. The currently authorized project was conceived and designed by COE, and they obviously prefer to see it completed. It would be unfair to stigmatize that agency as narrow-minded because each separate employee earnestly desires to do that which is right for all concerned. However, their established policies and activities introduce great inertia into COE operations which are reflected in a de-emphasis of any alternative except some permutation of the basic plan.

Summary. The following statements summarize findings from the survey of interest groups and their positions:

- (1) The need for flood control is an easily manipulated issue which both sides use to substantiate their position;
- (2) Emotionalism runs high because domestic water supply is involved. Each side accuses the other of subverting the needs of humans for other less important issues;
- (3) The most controversial issue appears to be whether water held behind the Jane Green reservoir will be transported to the south for irrigation of citrus. On the surface, this should be an easy question to answer. In reality, much confusion has been the case;

- (4) The main support for the present project appears to come from citrus interests, developers, and those in the Melbourne area who feel the project is best for the water supply situation;
- (5) Opposition appears to come from the conservation clubs, environmentally oriented agencies, and those in the Melbourne area who feel the project is not the answer to the water supply situation;
- (6) The cattlemen appear to be against the project because they prefer to be left alone. Their position is misunderstood by many of those in opposition to the project;
- (7) Although the environmentally oriented opposition forces have many legitimate issue-specific arguments, their fundamental reasons for opposition appear to go deeper to a feeling of misplaced priorities in water resources; and
- (8) The potential for conflict between farmer and conservationist types has much of its basis in a misunderstanding of the other's goals.

Generation of Data for CASM

Fourteen participants were identified as having substantial visibility in the St. Johns question. The overall complexion of this final group will generate a specific set of consequences for analyses to follow. For instance, suppose that actors were selected solely on the basis of whether they were or were not *affected* by the different management programs. In this instance, one might argue that valid statements could be made, from the analysis, about equity, fairness, etc. However, the procedure followed in the St. Johns study tended to uncover those actors with visible power and tangible stakes in the problem. Here, the complexion of the analysis shifts from the distribution of advantages and disadvantages to that of acceptability and feasibility. How likely is it that an acceptable proposal can be advanced? What are the forces that tend to move programs in one direction or another? The question of fairness must therefore penetrate

the analysis more indirectly. Given this brief qualification, the following list of interest groups was adopted:

ADOPTED SET OF DECISION PARTICIPANTS

1. Cattlemen No. 1
2. Cattlemen No. 2
3. Citrus Growers
4. Land Developers
5. Game and Fresh Water Fish Commission
6. Environmental Protection Agency
7. Audubon Society
8. League of Women Voters
9. Brevard County Commissioners
10. Flood Control District
11. Corps of Engineers
12. Melbourne City Council--Pro, COE Project
13. Melbourne City Council--Con, COE Project
14. Melbourne Citizens--Pro, COE Project

There are at least two basic types of interviewing techniques; one based on carefully controlled questionnaires, the other relying on more informal discussions. When questionnaires are used, one has the opportunity to extract systematic numerical data. However, this technique is limited in scope to the specific agenda used and further suffers from problems of interpretation of biased or misleading questions. In open-ended informal sessions, such hard data are more difficult to come by. However, the interviewee can cover a wide range of subjects, introduce new material, and include those subjective qualifications essential to an understanding of the issues involved.

Since, in this study, many tasks had to be accomplished in a single interview, rigid questionnaires were not constructed and tested; instead, the informal interview approach was employed. By soliciting general responses to various areas of interest, it was

possible to uncover central issues, to find out how participants viewed each issue and how they felt about other actors, to inquire about their perceptions of their own roles, and so on. Based on the results of such interviews, data similar to that described in Chapter V for CASM were developed by the investigative team.

McLaughlin [1973] should be consulted for more complete details; however, the following data provide a feel for the quality of information available. First, the list below identifies those issues which emerged as the dominant considerations of the participants interviewed. Remembering Chapter V and the different ways in which issues can be defined, this is not a list of social indicators, goal categories, physical plan descriptions, etc. Instead, this list should be viewed more properly as an array of politically-flavored issues. Each group held certain central concerns around which their support or opposition revolved. Thus, again, acceptability enters this analysis in a visible manner. Many groups were unaware of or knowledgeable about complex project details, and so the use of an extensive list of social indicators could have been counterproductive at this initial stage of interviewing.

ADOPTED SET OF CENTRAL ISSUES

1. Melbourne Water Supply
2. Irrigation Water
3. Amount of Agricultural Production
4. Amount of Residential Development
5. Water Quality
6. Marsh, Fish, and Wildlife Preservation
7. Recreational Opportunities
8. Degree of Flood Protection

Given this list, Table 6.2 contains information describing, for each interest group, a salience ranking of their top three issues. Regardless of whether the participant is "for" or "against," these issues rank in importance as first, second, and third. Table 6.3 lists the power coefficients assigned to each group. Ideological positions of each actor toward each issue are shown in Table 6.4. Goals structures for "soft line" and "hard line" positions can be found in Tables 6.5 and 6.6. Using the basic set of eight issues, a number of alternative plans are described in Table 6.7. Each entry is scaled for introduction into CASM in the same way that plans were represented in Chapter V.

Findings of Collective Action Analysis

At the outset, it was not clear how far collective action analyses could be extended into the St. Johns problem. Previous chapters have suggested that, under more carefully controlled conditions, the material put forward in this thesis could (1) serve as a set of overarching guiding principles, (2) steer analyses in a normative direction toward solutions which "should" be adopted, (3) describe the manner in which planning decisions might in actuality be taken, etc. However, in the St. Johns case, where time and resources were severely limited and where primary emphasis had to be placed on specific contractual arrangements, collective action seemed to serve more modest purposes. Thus, at the beginning of this results section, it can be concluded that the concepts and principles spelled out in earlier chapters need to become an integral part of planning

TABLE 6.2 ISSUE SALIENCE RANKING FOR EACH PARTICIPANT

PARTICIPANTS	ISSUE RANKING		
	First	Second	Third
1. Cattlemen No. 1	3	7	7
2. Cattlemen No. 2	3	8	1
3. Citrus Growers	2	3	3
4. Home Developers	4	8	1
5. Game and Fish Commission	2	6	5
6. EPA	5	6	5
7. Audubon Society	6	5	7
8. League of Women Voters	1	4	5
9. Brevard County Commission	1	8	7
10. Flood Control District	8	2	1
11. Corps of Engineers	8	2	1
12. Melbourne Council--Pro	1	1	8
13. Melbourne Council--Con	4	1	5
14. Melbourne Citizens--Pro	1	1	8

TABLE 6.3 POWER COEFFICIENTS FOR EACH PARTICIPANT

PARTICIPANTS	POWER COEFFICIENT
1. Cattlemen No. 1	0.053
2. Cattlemen No. 2	0.033
3. Citrus Growers	0.079
4. Home Developers	0.079
5. Game and Fish Commission	0.092
6. EPA	0.105
7. Audubon Society	0.118
8. League of Women Voters	0.072
9. Brevard County Commission	0.046
10. Flood Control District	0.092
11. Corps of Engineers	0.046
12. Melbourne Council--Pro	0.079
13. Melbourne Council--Con	0.066
14. Melbourne Citizens--Pro	0.040
Sum	1.000

TABLE 6.4 IDEOLOGICAL POSITION OF EACH GROUP
TOWARD EACH PROJECT COMPONENT

GROUP NUMBER	ISSUE NUMBER							
	1	2	3	4	5	6	7	8
1.	0.20	0.60	0.90	-0.30	-0.20	-0.60	-0.70	-0.20
2.	0.30	0.60	0.95	-0.40	-0.20	-0.50	-0.70	0.20
3.	0.20	0.95	0.95	0.00	-0.20	-0.60	-0.30	0.70
4.	0.85	0.00	0.00	1.00	0.30	-0.20	0.50	0.95
5.	0.70	-0.70	-0.70	-0.70	0.85	0.80	0.50	-0.30
6.	0.30	-0.30	-0.30	0.00	0.85	0.65	0.00	0.00
7.	0.50	-0.90	-0.70	-0.70	0.80	0.80	0.70	-0.50
8.	0.70	-0.70	-0.40	-0.80	0.70	0.70	0.60	-0.30
9.	0.95	0.20	0.10	0.50	0.20	0.10	0.60	0.60
10.	0.30	0.70	0.35	0.00	-0.10	-0.20	0.15	0.80
11.	0.10	0.80	0.10	0.00	-0.10	-0.40	0.35	0.80
12.	0.95	0.00	0.00	0.40	0.10	-0.30	0.00	0.70
13.	0.85	-0.70	-0.40	-0.90	0.50	0.50	0.10	-0.40
14.	0.95	0.00	0.00	0.50	0.20	0.10	0.40	0.70

-1 = most negative position; +1 = most positive position.

TABLE 6.5 GOALS STRUCTURE FOR EACH GROUP UNDER "SOFT LINE" POSITIONS

GROUP NUMBER	ITEM	ISSUE RANKINGS			GROUP NUMBER	ITEM	ISSUE RANKINGS		
		First	Second	Third			First	Second	Third
1	WGOALS	(3) 0.90	(7) 0.05*	(7) 0.05*	8	WGOALS	(1) 0.70	(4) 0.30*	(5) 0.75
	TVYES	0.75	0.65	0.65		TVYES	0.70	0.80	0.75
	TVNO	0.50	0.45	0.45		TVNO	0.50	0.50	0.35
2	WGOALS	(3) 0.90	(8) 0.70	(1) 0.60	9	WGOALS	(1) 0.85	(8) 0.80	(7) 0.80
	TVYES	0.75	0.40	0.30		TVYES	0.75	0.60	0.65
	TVNO	0.50	0.15	0.10		TVNO	0.55	0.25	0.30
3	WGOALS	(2) 0.90	(3) 0.90	(3) 0.90	10	WGOALS	(8) 0.90	(2) 0.90	(1) 0.65
	TVYES	0.80	0.75	0.75		TVYES	0.65	0.70	0.50
	TVNO	0.50	0.55	0.55		TVNO	0.30	0.40	0.15
4	WGOALS	(4) 0.85	(8) 0.90	(1) 0.90	11	WGOALS	(8) 0.90	(2) 0.90	(1) 0.65
	TVYES	0.70	0.75	0.55		TVYES	0.65	0.75	0.30
	TVNO	0.45	0.20	0.35		TVNO	0.15	0.30	0.10
5	WGOALS	(2) 0.20*	(6) 0.85	(5) 0.80	12	WGOALS	(1) 0.80	(1) 0.80	(8) 0.90
	TVYES	0.60	0.75	0.75		TVYES	0.75	0.75	0.55
	TVNO	0.35	0.60	0.40		TVNO	0.50	0.50	0.30
6	WGOALS	(5) 0.80	(6) 0.75	(5) 0.80	13	WGOALS	(4) 0.25*	(1) 0.70	(5) 0.70
	TVYES	0.80	0.60	0.80		TVYES	0.80	0.70	0.70
	TVNO	0.55	0.35	0.55		TVNO	0.55	0.45	0.35
7	WGOALS	(6) 0.90	(5) 0.90	(7) 0.80	14	WGOALS	(1) 0.80	(1) 0.80	(8) 0.85
	TVYES	0.80	0.80	0.70		TVYES	0.75	0.75	0.60
	TVNO	0.55	0.50	0.25		TVNO	0.55	0.55	0.30

NOTE: Numbers in parentheses are the adopted ISSUE NUMBERS.

* Negatively sloped preference function; all others positively sloped.
WGOALS = Ideal goals. TVYES = Aspiration level. TVNO = Exasperation level.

TABLE 6.6 GOALS STRUCTURE FOR EACH GROUP UNDER "HARD LINE" POSITIONS

GROUP NUMBER	ITEM	ISSUE RANKINGS			GROUP NUMBER	ITEM	ISSUE RANKINGS		
		First	Second	Third			First	Second	Third
1	WGOALS	(3) 0.90	(7) 0.05*	(7) 0.05*	8	WGOALS	(1) 0.70	(4) 0.30*	(5) 0.75
	TVYES	0.90	0.85	0.85		TVYES	0.75	0.90	0.85
	TVNO	0.60	0.50	0.50		TVNO	0.65	0.65	0.45
2	WGOALS	(3) 0.90	(8) 0.70	(1) 0.60	9	WGOALS	(1) 0.85	(8) 0.80	(7) 0.80
	TVYES	0.90	0.45	0.40		TVYES	0.90	0.70	0.75
	TVNO	0.60	0.40	0.25		TVNO	0.65	0.30	0.35
3	WGOALS	(2) 0.90	(3) 0.90	(3) 0.90	10	WGOALS	(8) 0.90	(2) 0.90	(1) 0.65
	TVYES	0.90	0.90	0.90		TVYES	0.75	0.85	0.60
	TVNO	0.60	0.60	0.60		TVNO	0.35	0.60	0.25
4	WGOALS	(4) 0.85	(8) 0.90	(1) 0.90	11	WGOALS	(8) 0.90	(2) 0.90	(1) 0.65
	TVYES	0.85	0.80	0.70		TVYES	0.75	0.85	0.40
	TVNO	0.55	0.30	0.40		TVNO	0.25	0.60	0.20
5	WGOALS	(2) 0.20*	(6) 0.85	(5) 0.80	12	WGOALS	(1) 0.80	(1) 0.80	(8) 0.90
	TVYES	0.70	0.85	0.90		TVYES	0.90	0.90	0.65
	TVNO	0.45	0.60	0.50		TVNO	0.70	0.70	0.40
6	WGOALS	(5) 0.80	(6) 0.75	(5) 0.80	13	WGOALS	(4) 0.25*	(1) 0.70	(5) 0.70
	TVYES	0.95	0.80	0.95		TVYES	0.95	0.85	0.85
	TVNO	0.65	0.45	0.65		TVNO	0.70	0.65	0.45
7	WGOALS	(6) 0.90	(5) 0.90	(7) 0.80	14	WGOALS	(1) 0.80	(1) 0.80	(8) 0.85
	TVYES	0.95	0.95	0.75		TVYES	0.95	0.95	0.70
	TVNO	0.75	0.60	0.30		TVNO	0.75	0.75	0.35

NOTE: Numbers in parentheses are the adopted ISSUE NUMBERS.

* Negatively sloped preference functions. All others positively sloped.

WGOALS = Ideal goals. TVYES = Aspiration level. TVNO = Exasperation level.

TABLE 6.7 A SUMMARY OF "SCALED" ST. JOHNS PLANS

PLAN DESIGNATION*	MELBOURNE WATER SUPPLY (1)	IRRIGATION WATER (2)	AGRICULTURAL PRODUCTION (3)	RESIDENTIAL DEVELOPMENT (4)
1. A1	0.45	0.10	0.90	0.80
2. A3	0.60	0.75	0.65	0.80
3. A4	0.80	0.25	0.70	0.80
4. B1	0.80	0.60	0.60	0.80
5. B2	0.60	0.90	0.55	0.80
6. D2	0.80	0.15	0.40	0.35

PLAN DESIGNATION*	WATER QUALITY (5)	PRESERVATION OF MARSH, FISH & WILD. (6)	RECREATION OPPORTUNITY (7)	FLOOD PROTECTION (8)
1. A1	0.35	0.35	0.30	0.20
2. A3	0.40	0.65	0.60	0.55
3. A4	0.60	0.65	0.40	0.50
4. B1	0.40	0.20	0.50	0.80
5. B2	0.35	0.20	0.70	0.90
6. D2	0.80	0.95	0.20	0.50

* See Table 6.1.

behavior if its promises are to be *fully* realized. It takes time for an agency to develop a feeling for affected groups, to extend stable lines of communication, and for groups to begin to understand their position in the overall problem. Consequently, a one-shot application of collective action principles, by an outside consultant, should not be expected to yield its full measure of possible results. A one-shot introduction does not permit proper feedback or necessary follow-up on results which can be advanced. So, this portion of the St. Johns study turned out to be not a fundamental test of concepts and principles from this thesis, but instead, an attempt to see just what the collective action approach can do under these limited circumstances. The following paragraphs can thus be viewed as an attempt to describe these accomplishments.

Chapter V systematically described the information needs for CASM and the range of results which can be generated by this particular technique. (CASM by itself should not be confounded with the more encompassing collective action approach. Its input requirements and output possibilities are much broader.) Figures 5.5 and 5.6 (pp. 293, 294) in particular contain example computer printouts showing the information provided after each arena interaction. This same type of information is available for each St. Johns plan submitted to CASM. However, instead of displaying all of these results, Tables 6.8, 6.9, and 6.10 summarize the probabilities of success, tie or stalemate, and failure for each plan under a variety of conditions.

TABLE 6.8 PROBABILITY* OF SUCCESS FOR EACH ST. JOHNS PLAN
UNDER VARIOUS CASM CONDITIONS

DECISION RULE	SOFT LINE						HARD LINE					
	PLAN DESIGNATION						PLAN DESIGNATION					
	A1	A3	A4	B1	B2	D2	A1	A3	A4	B1	B2	D2
PLURALITY RULE:												
PLURALITY POWER												
One-way conflict	15	64	100	86	62	100	0	1	97	62	20	100
Two-way conflict	10	100	100	100	100	100	0	7	99	100	49	100
No conflict	7	100	96	86	100	100	0	6	88	74	59	100
PLURALITY VOTES												
One-way conflict	7	96	100	100	100	96	0	10	98	100	45	91
Two-way conflict	22	100	100	100	100	97	0	17	99	100	89	99
No conflict	16	100	100	100	100	100	0	1	96	100	38	100
MAJORITY RULE:												
MAJORITY POWER												
One-way conflict	0	6	29	30	10	53	0	0	12	9	0	56
Two-way conflict	0	84	93	79	79	94	0	4	82	64	30	100
No conflict	9	100	100	84	100	100	0	2	93	77	50	100
MAJORITY VOTES												
One-way conflict	0	16	38	23	16	6	0	0	21	12	0	17
Two-way conflict	2	95	97	90	100	83	0	1	91	90	34	86
No conflict	14	100	100	100	100	100	0	3	98	100	46	100
2/3 RULE:												
2/3 POWER												
One-way conflict	0	0	0	0	0	2	0	0	1	0	0	1
Two-way conflict	0	0	53	2	0	46	0	0	20	0	0	39
No conflict	0	46	75	11	0	79	0	0	22	0	0	77
2/3 VOTES												
One-way conflict	0	0	5	3	0	1	0	0	1	0	0	0
Two-way conflict	0	12	74	24	0	26	0	0	36	12	0	28
No conflict	0	80	90	48	0	74	0	0	49	27	0	71

* Probability expressed as a percent.

TABLE 6.9 PROBABILITY* OF A TIE OR STALEMATE FOR EACH ST. JOHNS
PLAN UNDER VARIOUS CASM CONDITIONS

DECISION RULE	SOFT LINE						HARD LINE					
	PLAN DESIGNATION						PLAN DESIGNATION					
	A1	A3	A4	B1	B2	D2	A1	A3	A4	B1	B2	D2
PLURALITY RULE:												
PLURALITY POWER												
One-way conflict	2	13	0	6	38	0	0	0	0	24	14	0
Two-way conflict	6	0	0	0	0	0	0	8	0	0	0	0
No conflict	7	0	4	0	0	0	0	0	7	0	0	0
PLURALITY VOTES												
One-way conflict	18	4	0	0	0	4	0	24	2	0	36	8
Two-way conflict	14	0	0	0	0	3	0	10	1	0	11	1
No conflict	31	0	0	0	0	0	0	16	4	0	62	0
MAJORITY RULE:												
MAJORITY POWER												
One-way conflict	99	94	71	70	90	47	93	95	88	91	100	46
Two-way conflict	57	16	7	21	21	6	16	52	18	36	70	0
No conflict	5	0	0	0	0	0	0	0	0	0	0	0
MAJORITY VOTES												
One-way conflict	100	84	62	77	84	94	96	100	79	88	100	83
Two-way conflict	81	5	3	10	0	17	18	86	7	10	66	14
No conflict	35	0	0	0	0	0	0	13	2	0	54	0
2/3 RULE:												
2/3 POWER												
One-way conflict	100	100	100	100	100	98	100	100	99	100	100	99
Two-way conflict	96	100	47	98	100	54	79	98	80	100	100	61
No conflict	87	54	25	89	100	21	29	57	78	100	100	23
2/3 VOTES												
One-way conflict	100	100	95	97	100	99	100	100	99	100	100	100
Two-way conflict	99	88	26	76	100	74	90	100	64	88	100	72
No conflict	98	20	10	52	100	26	22	87	51	73	100	29

* Probability expressed as a percent.

TABLE 6.10 PROBABILITY* OF DEFEAT FOR EACH ST. JOHNS PLAN
UNDER VARIOUS CASM CONDITIONS

DECISION RULE	SOFT LINE						HARD LINE					
	PLAN DESIGNATION						PLAN DESIGNATION					
	A1	A3	A4	B1	B2	D2	A1	A3	A4	B1	B2	D2
PLURALITY RULE:												
PLURALITY POWER												
One-way conflict	83	23	0	8	0	0	100	99	3	14	66	0
Two-way conflict	84	0	0	0	0	0	100	85	1	0	51	0
No conflict	86	0	0	14	0	0	100	94	5	26	41	0
PLURALITY VOTES												
One-way conflict	75	0	0	0	0	0	100	66	0	0	19	1
Two-way conflict	64	0	0	0	0	0	100	73	0	0	0	0
No conflict	53	0	0	0	0	0	100	83	0	0	0	0
MAJORITY RULE:												
MAJORITY POWER												
One-way conflict	1	0	0	0	0	0	7	5	0	0	0	0
Two-way conflict	43	0	0	0	0	0	84	46	0	0	0	0
No conflict	86	0	0	16	0	0	100	98	7	23	50	0
MAJORITY VOTES												
One-way conflict	0	0	0	0	0	0	4	0	0	0	0	0
Two-way conflict	17	0	0	0	0	0	82	13	0	0	0	0
No conflict	51	0	0	0	0	0	100	84	0	0	0	0
2/3 RULE:												
2/3 POWER												
One-way conflict	0	0	0	0	0	0	0	0	0	0	0	0
Two-way conflict	4	0	0	0	0	0	21	2	0	0	0	0
No conflict	13	0	0	0	0	0	71	43	0	0	0	0
2/3 VOTES												
One-way conflict	0	0	0	0	0	0	0	0	0	0	0	0
Two-way conflict	1	0	0	0	0	0	10	0	0	0	0	0
No conflict	2	0	0	0	0	0	78	13	0	0	0	0

*Probability expressed as a percent.

If time permitted, there are a number of analytical techniques which could be applied to this basic data, even in this rough form. For example, as displayed, these numbers are in excellent form for introduction into a linear statistical model. Such an exercise would provide estimates of the significance of each variable, soft/hard line, one-way/two-way/no conflict, and plurality/majority/two-thirds or power/vote decision rules. However, for our purposes the tables by themselves can provide a feeling for the manner in which each variable influences arena responses. These influences are similar to those observed in Chapter V:

- (1) Arena responses are similar whether focusing on power or votes. This can be attributed partially to the model's construction but more likely to the fact that power was presumed to be distributed somewhat evenly over the fourteen participants. The procedure for inventorying power, described in Chapter V, focuses on one's effective power relative to the *total* decision situation, from beginning to end. In this sense, these more uniform findings seem reasonable. What the inventory procedure does not account for is the way in which power fluctuates over individuals, depending on the particular decision stage. The St. Johns study was carried out within a specific, identifiable phase in the decision trajectory. Given this external circumstance, a more reasonable approach might have been to assess the distribution of power peculiar to this planning stage. For instance, right now the balance of power seems to reside with those participants who express concerns for environmental quality. This type of realization only confirms the discussions in Chapter IV which emphasized the need to consider carefully those factors which influence the ebb and flow of power throughout the decision situation.
- (2) Soft line, compromising positions again allow more plans to succeed with higher probabilities and likewise reduce the chances that a plan can be defeated outright. Here, the runs were made with everyone assuming a soft line, then everyone assuming a hard line. An interesting extension would be to explore a mixture of these positions permitting some actors to be hard-headed and aggressive while others would reflect a desire to compromise.

- (3) The *type* of conflict does not seem to affect the number of plans which can be defeated outright. This finding describes a characteristic of the St. Johns conflict which will be discussed later. The basic idea is that serious opposition to any listed proposal can be developed in the Upper St. Johns only with considerable difficulty. But this opposition, once developed, becomes very solidified in purpose and cannot easily break apart. So, the type of conflict assumed has small effect on the occurrence of outright defeat. The same finding does not hold true for outright success. Each plan seems to provide a little something for almost every participant, so many can jump on the bandwagon, each for his own personal reasons. In this instance, the type of conflict assumed does have noticeable effect; less committed members cannot be solidified as readily into cohesive groups.
- (4) The choice of a decision rule has a similar effect as that described in Chapter V. A two-thirds rule favors the status quo. Proposals cannot be easily passed or defeated outright; the probability of a tie or stalemate rises to a high level. For majority rule, few plans can be defeated outright; however, most proposals can generate a majority of favorable support. This reflects back to an earlier remark which suggested that, in the St. Johns conflict, concerted opposition to any listed proposal does not seem to materialize easily. Even though, under majority rule the chances of producing a tie improves for the minority position, there is still a substantial chance that an entrenched majority can easily railroad proposals over minority objections. Such is not the case for 2/3 rule where the rule itself protects minorities against having to accept solutions counter to its own priorities. For plurality rule, unlike Bow Valley, a systematic disregard for minority positions becomes even more pronounced. In Bow Valley, this rule permitted the minority to gain some middle-of-the-road support and thereby rise to at least a plurality position and in this way be heard. Different decision circumstances in the St. Johns prevent this phenomenon from occurring. Hence, for plurality requirements, the chance of outright defeat is greatly reduced for any listed plan that might be put forward into this arena-type climate. This may be due partially to the fact that only a limited set of plans were available for submission to the area. A wider range of substantially different proposals might have been able to generate more obvious opposition.

Again, these data are ripe for analysis by other especially multivariate techniques, and in addition, the previous line of inquiry can be continued in greater detail. But, the collective action analysis,

even at this rudimentary level, can perform other services as well. It is now time to explore these capabilities.

First, consider plan A1; each of the Tables 6.8, 6.9 and 6.10 show that A1 is very poorly received with high chance of defeat and low chance of success under a wide range of conditions. Proposal A1 provides very little for any participant except possibly certain agricultural and development interests who would like to see past investment trends continue into the future. Most certainly, a program similar to A1 would not survive, thus, A1 will be dropped from further consideration.

This illustrates an initial accomplishment of the collective action analysis. An early screening of clearly unpopular proposals can be performed. Although it was not followed for the St. Johns study, a similar type of rapid screening would be valuable to the early stages of the research effort itself. By performing a series of interactions with CASM, a more clearly defined set of plans could be provided at the outset. It would also seem possible to generate a broader set of acceptable proposals, some quite different from the facilities-oriented programs, which could be subjected to the fuller research effort, like all other alternatives.

Suggesting in this manner that collective action analysis could provide valuable services during the early stages of research and planning activities does not necessarily mean that a study of the local integrative problem must be totally complete before research and planning can begin. For instance, the current St. Johns CASM must be considered rudimentary, yet it can still point out poorly conceived programs and specific areas of difficulty.

In addition to preliminary screening, the analysis can be used to uncover basic forces which tend to move programs in one direction or another. This might include an identification of (1) dominant and/or confounding issues, (2) new unthought-of issues and participants, (3) disruptive features of the decision situation, (4) avenues for improving planning behavior, etc. In the St. Johns case, many of the findings in this area confirmed our intuitive judgements, however, a sounder basis for recommendations and subsequent study has been established.

The paragraphs to follow expand upon this line of inquiry. As these analyses unfolded, it became apparent to the study team that the findings could not be viewed as final conclusions. The identification of participants, the interviews, and the later processing of this information by CASM had uncovered only the visible portion of the St. Johns iceberg. But, at the same time, the analysis began to unveil that nine-tenths lying below the surface. Moreover, the collective action approach exposed these additional features in a way that would organize and direct any attempts to explore them further.

One distinguishing characteristic of the St. Johns situation is that *few seem to have a clear understanding of the problem as a whole or the solutions which have been proposed for it.* Even the construction agencies who, of course, have intimate knowledge of the details of proposed facilities, often fail to perceive the entire problem and the true profile of consequences which might flow from alternative plans. And certainly, those other groups with more issue-specific

concerns often demonstrated a lack of knowledge about project features beyond their most immediate interests. The St. Johns study team, however, because they were required to face the many issues of the *total* problem are probably as sensitized to the system-wide complexities as any of the participants. Even so, this more holistic perspective forced the study team to submerge and lay aside many technical and nontechnical details which all would agree were very important. Thus, it can be concluded without hesitation that no single participant, including those organizations with supposedly overarching concerns, has a true grasp of the total problem and its interacting complexities.

Each of the identified influentials acts primarily on the basis of a reduced set of concerns central to himself. Now, it *is* a possibility that the best overall solution can be produced by a collection of actors seeking only to do the best they can along their most central concerns. But, this runs counter to concepts presented in this thesis. Furthermore, it became generally recognized by the study team that the lack of wider knowledge on the part of St. Johns participants was a major disruptive factor to a smoother resolution of pressing issues. Thus, lack of fuller knowledge and the effects which flow from it became a primary concern of this chapter.

A brief aside here will be useful to the discussions which follow. It has long been recognized that the particular level of one's preferences has little meaning in decision analysis unless they are framed by that which one is willing to give up in order to satisfy these preferences. If a decision maker unwittingly gives up in value

something which exceeds the value of an object obtained, then most observers would agree that the trade was undesirable and unfortunate. Chapter IV at several points suggested that, although such tradeoff factors are valuable to an understanding of both unitary and collective decisions, people are generally unwilling to be specific about the tradeoff values which they might prefer. Even so, the study team agreed that a more detailed understanding of tradeoff factors was essential to a meaningful analysis of the St. Johns problem, ignoring the fact that specific groups might not be able to be specific about their own factors.

Such tradeoffs fall into at least two groups: (1) that which I knowingly *or unknowingly* lose myself as a result of gaining something and, in the event that *I* lose very little, (2) that which is lost by the total system or by someone else, as I satisfy my own preferences. Since the conflict in question has been characterized by a general lack of information on the part of various participants, it was accepted as a first order of business the task of simply identifying those tradeoffs of overriding importance. If time permits the magnitude and importance of these factors can also be explored.

How does a tradeoff, or more precisely a lack of knowledge about tradeoffs, affect that portion of the St. Johns study addressed by collective action analysis? The diagrams in Figures 6.7, 6.8, and 6.9 begin to develop a feel for this influence. Looking at each issue separately, the first two figures simply plot the probability of success and tie/stalemate (likelihood of outright defeat not shown) versus the levels of each issue. The third figure describes the

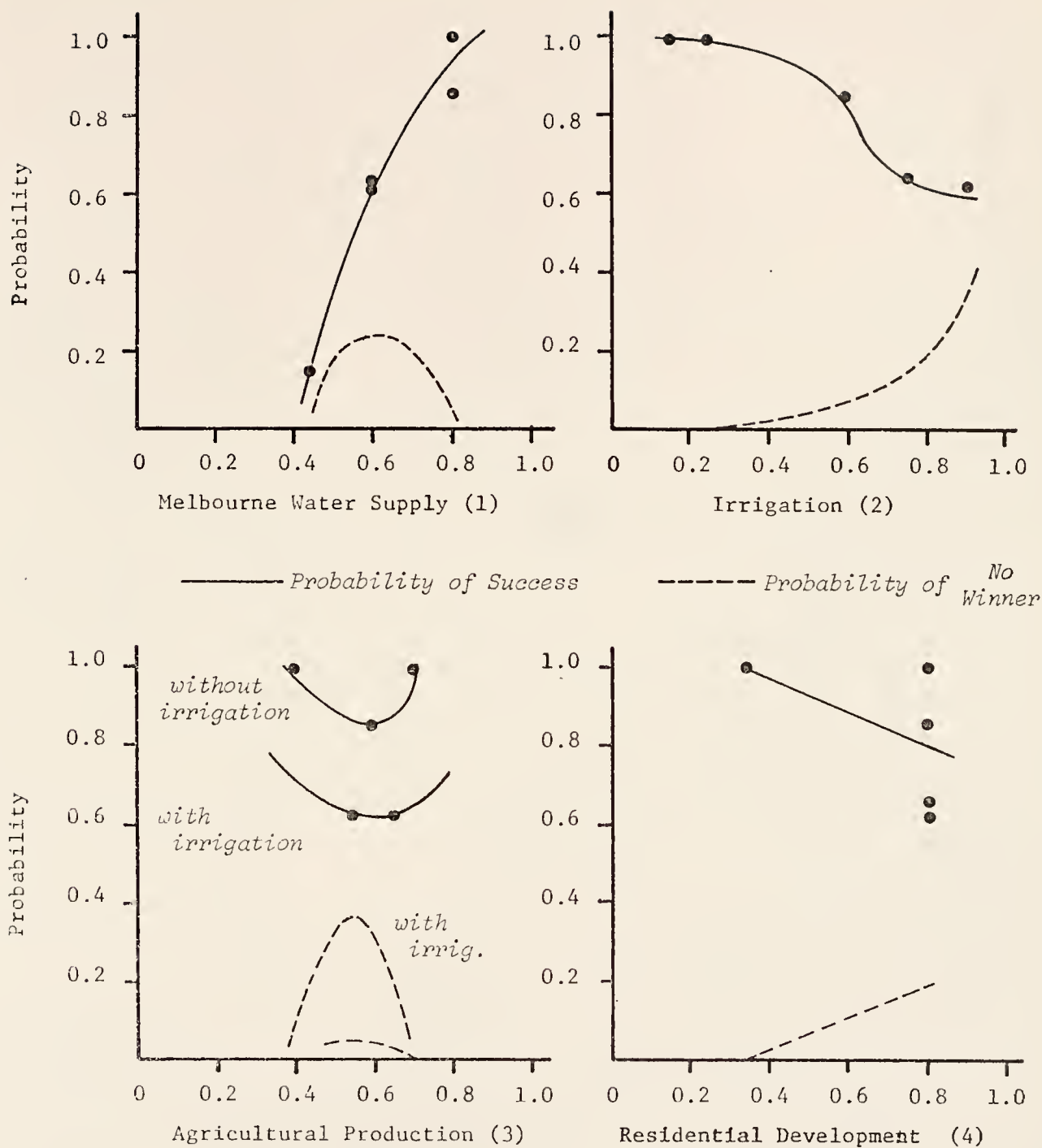


Figure 6.7 Arena Response to St. Johns Issues, Numbers (1) Through (4)

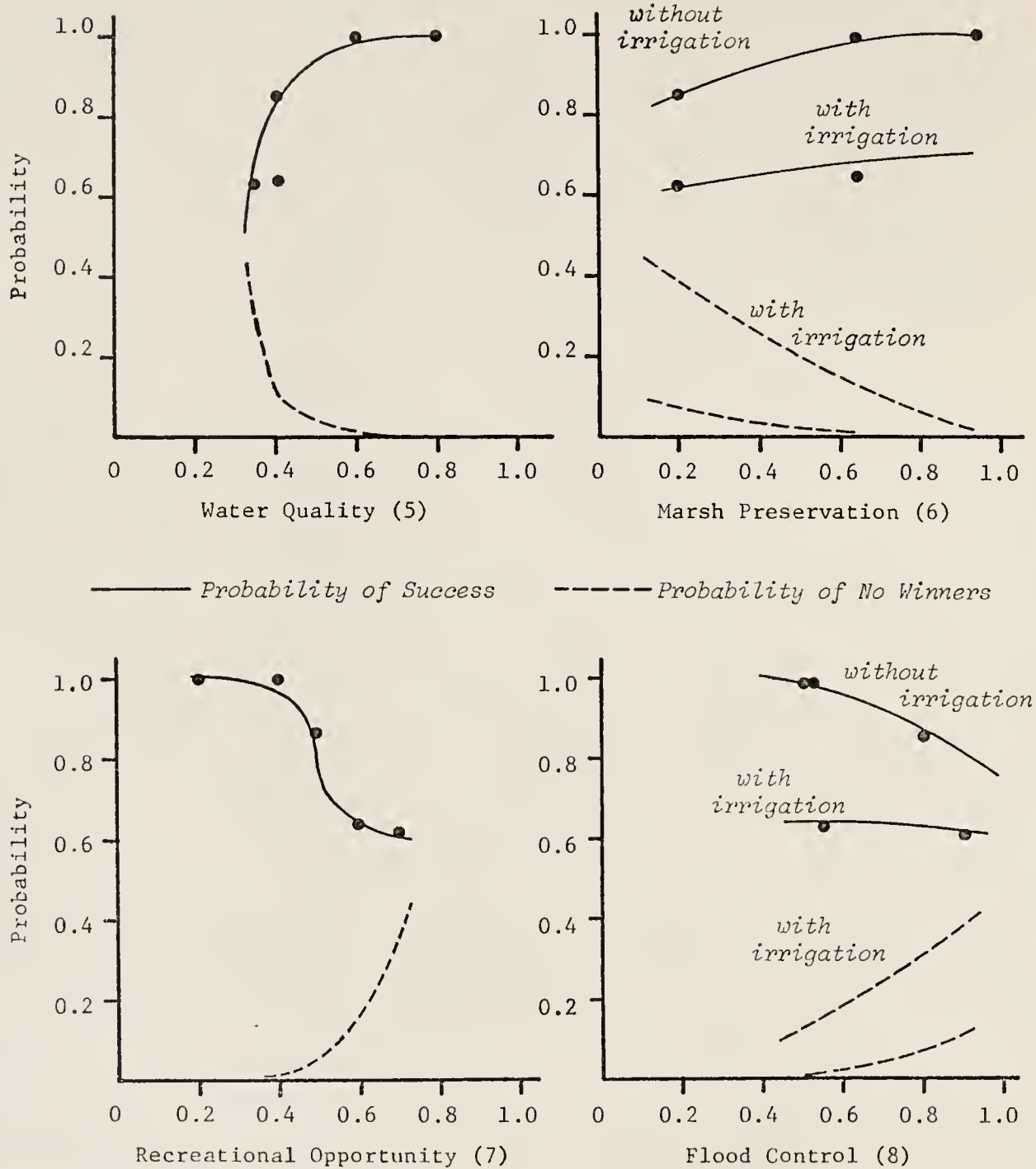
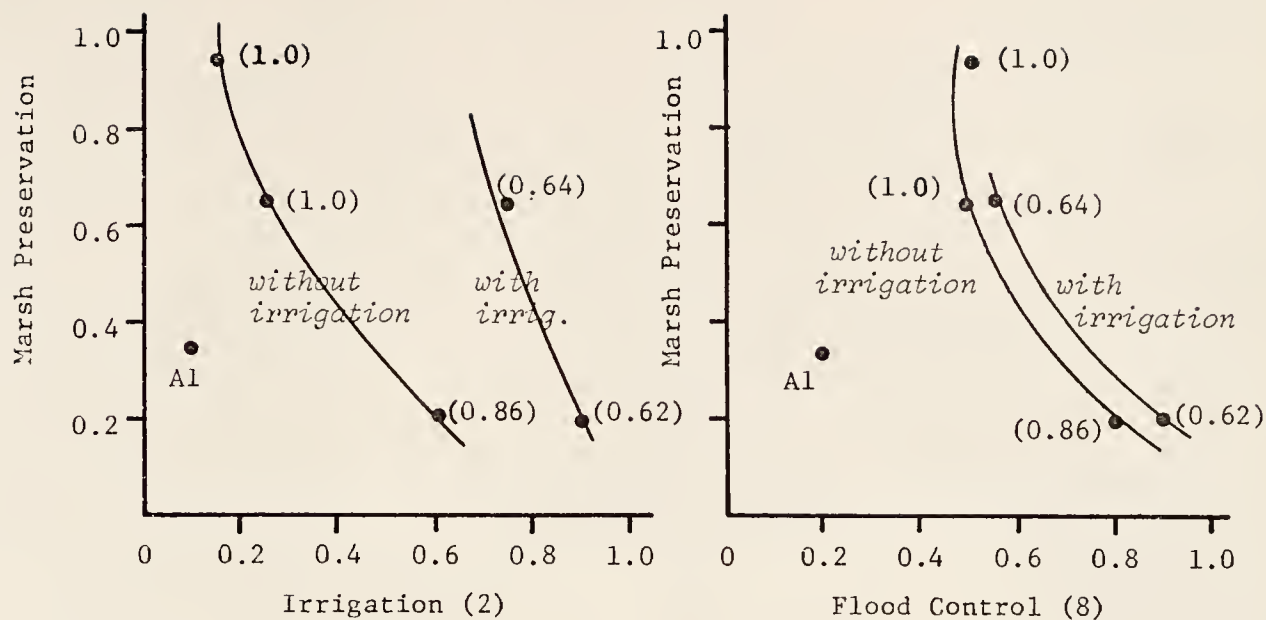


Figure 6.8 Arena Response to St. Johns Issues, Numbers (5) Through (8)



NOTE: Numbers in Parentheses Represent Probability of Success

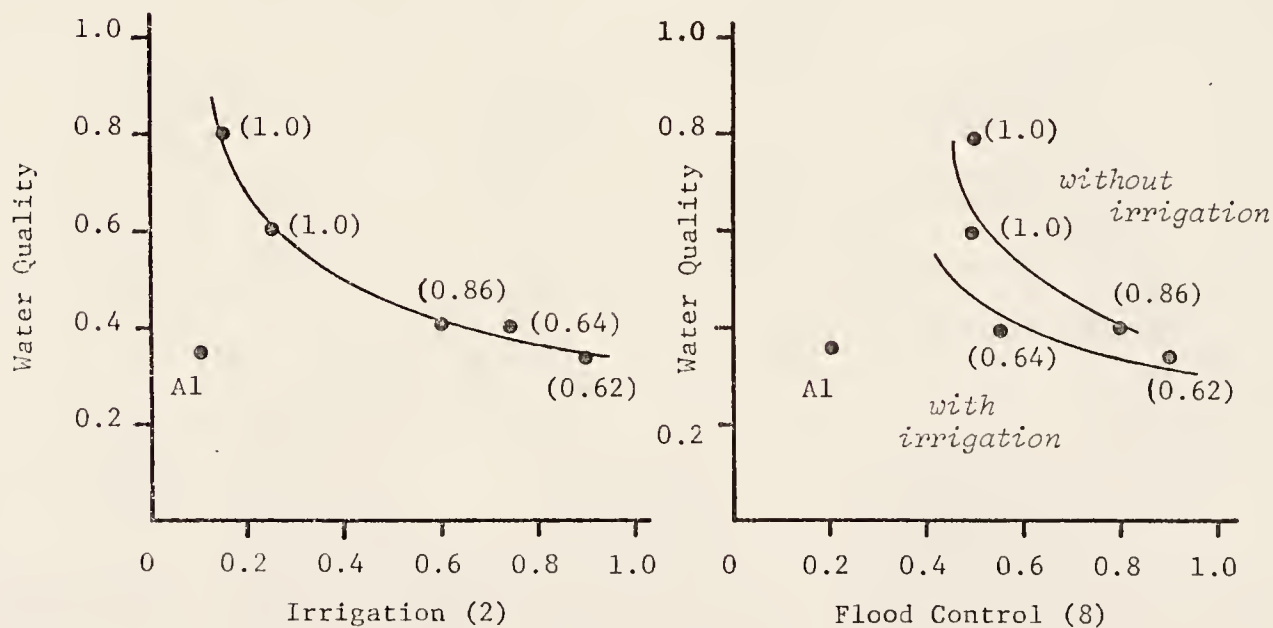


Figure 6.9 Tradeoff Between Selected St. Johns Issues, in Terms of Arena Responses

manner in which selected issues interact, including the arena responses to various levels of interaction.

CASM itself does not consider what each group would be willing to *give up* to attain their primary goals; groups are presumed to be guided only by their own goals structures. Any suggestion of tradeoff enters by way of opposing or competing interests who likewise consider only their own preferences. Fortunately, as previously noted, this likewise characterizes the St. Johns conflict, and so CASM results can be looked at with more interest.

How might a given issue move proposals in one direction or another? Acceptability seems to increase as Melbourne water supply (1), water quality (5), and marsh preservation (6) increase. Acceptability decreases as irrigation (2), recreational opportunity (7), and "structural" flood control (8) increase. Less can be said about agricultural production (3) and residential development (4). All issues except these last two, (3) and (4), can be viewed as having a more clear-cut influence; (3) and (4) are somewhat vague concerns and thus enter the analysis less as prominent forces but more as confounding factors.

Is it this simple? Of course not. There is not enough evidence yet to point to any issue as a dominant force. Each issue was mainly a political-like concern of one or more of the participants interviewed. For instance, looking at graph (5), acceptability increases not only as water quality by itself improves, it also increases as a result of the interactions of other groups pursuing other seemingly unrelated issues. In fact, with this version of CASM there exists an eight-dimensional

set of possible important interactions. Thus, a single curve in Figures 6.7 and 6.8 should be viewed only as the reflection of a curved surface in n-space onto a particular axis. Cause-and-effect between a given issue and its acceptability can be understood only in the context of other interacting issues.

The graphs in Figure 6.9 begin to explore selected two-way interactions. For example, as irrigation and flood control increase both water quality and marsh preservation decrease. (This was primarily a subjective judgement of the survey team.) Moreover, if we can employ the probability of success as a measure of the desirable tradeoff, then this figure begins to isolate those areas of the "proposal space" where planners might begin to focus their concerns.

Again, is it that simple? Again, no. For instance, plan D2 was generally well received and, for these specific graphs, enjoyed a 100 percent chance of success. D2, remember, was that plan which would have set aside MLRA 156 as an area free from development, the virgin floodplain. But, much of this region has already been de-developed, and as a consequence, D2 would also require extensive development. Such a proposal might be well received in certain preservation circles, however, reason suggests that the attendant hardships would surely bring disfavor upon D2, at least for this point in time.

Given this, why does the arena respond so favorably to D2? On closer inspection D2 provides a little something for nearly everyone along the eight major issues identified. Thus, since they consider only their primary concerns, many supporters for D2 can be found. What is missing from the analysis is the nature of tradeoffs involved.

Each group is generally unaware of what he or the total system might forfeit as a result of his attachment to D2 and his pursuit of short term goals. Now, D2 does not truly serve as a good example because most reasonable participants can visualize the hardships associated with this exaggerated proposal, even though CASM is blind to these factors. But, what about Melbourne water supply? This issue is surrounded by much political power that can be exerted in the direction of improving the supply regardless of its effect on other related issues. For example, a full-blown construction project might insure a large quantity of stored water for Melbourne consumption. Their support of a large project like this, on the grounds of water supply only, tends to push through the proposal on the basis of a single issue and submerges possible negative effects the project may have for other issues. So, the effect of a lack of knowledge of tradeoffs, illustrated by the rather extreme D2, still enters the conflict in a very real way through less extreme proposals.

It is now clearer why the collective action analysis, and indeed the entire St. Johns Study, was described earlier as only a beginning effort. At this stage in the investigation, the findings are only now beginning to clarify the more critical areas of concern. They now suggest where further effort should be concentrated. It would now be possible to go back to the participants, including new ones uncovered during the study, with a more refined set of issues and trade-off problems. With broader agency support, this information could serve to increase the level of understanding by all involved persons.

The existing situation tends to resemble a zero-sum conflict, requiring a "go" or "no go" on existing facilities which generate a profile of distinct winners and losers. Chapter IV described the undesirability of this type of condition and the fact that one hopeful way out of zero-sum conflict is to change-the-game. Moreover, Chapter IV described the way in which the conceptual arena as a vehicle for new issues, could be employed for this purpose. If accomplishing nothing else, the collective action analysis has revealed that the limited often ill-perceived issues, which dominate the perceptions of each participant, have served to lock-in this zero-sum flavoring. Furthermore, the analysis has identified other more critical issues which can serve to change-the-game, hopefully, in a direction which would permit more meaningful cooperation among participants.

For instance, CASM was not the only source of new issues; the study as a whole uncovered other critical driving forces in the St. Johns problem, namely, the desirable alternative future, and under this, the ratio to be held between acres of improved pasture and open rangeland. Using what have been accepted as plausible agricultural demands for future growth, all but 25-30 percent of total available St. Johns land would be consumed (by 2020) by citrus, vegetable, and beef production alone. All other conceivable land uses would have to divide up that 25-30 percent land residuum. In some areas of the basin the residuum was almost zero. Since water and agricultural activities are intimately entwined in the Upper St. Johns basin, the alternative future (in this instance, the agricultural demands to be met) emerged

as a dominant driving force for this water resource conflict. Within this factor, the amount of land converted to high intensity improved pasture and the amount retained as open rangeland became a critical consideration.

Thus, the study uncovered certain salient phenomena which might serve to redirect the conflict from a zero-sum state to one in which cooperation might grow relative to a changed or broadened game. For sure, the original set of personally perceived issues, which do not capture the essence of the true problem, can now be related to issues which do in actuality dominate the problem. It might be possible to shift the focus of attention away from reduced sets of personal concerns to a consideration of alternative futures and the desirable level of growth. (Other phases of the St. Johns study provide revealing technical findings relative to the consequences which might flow from alternative growth patterns.) It is conceivable that once interested participants accept the level or rate of growth as an overriding central issue, then they would be willing to shift their attention to this as their immediate concern. Barring this occurrence, it would certainly be possible to take their broadened set of personal concerns, including their tradeoffs, and to relate these to the question of growth. For instance, a group primarily interested in irrigation could now cast this immediate concern in terms of its relation to growth and the resulting pattern of land use. A continuing assessment and reassessment like this will begin to adjust the original set of confounding issues into a set which has more meaningful bearing on the total problem. In this way, our preliminary study of the iceberg above the

surface provides meaningful guidance for further analysis of that portion which still exists hidden below.

What exactly does this accomplish? It clarifies and illuminates the factors in the planning situation and provides the overarching framework within which these issues can be studied. It emphasizes that a range of participants, each with a stake and power in the conflict, view the problem differently; moreover, one can now begin to piece together the way in which these diverse views and values interact around certain central driving issues. Given this ability to unify fragmented components of a total water management problem, it becomes thinkable to consider the interactions flowing from any given distribution of advantages and disadvantages. Each plan carries with it a profile of consequences for each participant. How do they respond? And what do these responses mean for planning activities and the state of the system? Which distributions seem fair and just and what criteria were used for this assessment? These considerations and others, using the collective action approach, are also referred to a broader range of fundamental governing laws, both technical and nontechnical. In this thesis, examples of these fundamental principles were provided by the General Theory of Action, the General Theory of Planning, and the basic patterns of collective decision behavior outlined in Chapter IV.

But, what *specific* statements can be made about the St. Johns? Twelve different proposals were formulated for the St. Johns study and divided into four basic groups (see Table 6.1). Group D, the virgin floodplain plan, was added to the list, more than anything, to broaden the flavor of proposals considered. So, within the purview of the

study, there were actually three basic alternatives which would receive serious attention: (A) no public agency action; (B) implement the COE plan; and (C) prevent further encroachment and build only selected structures. Since some of the twelve subproposals were only slightly different, it was possible to define for CASM six distinct alternatives. These were used to construct the diagrams in Figures 6.7, 6.8, and 6.9. The point to be made here is that, although one *can* investigate one, two or three alternatives, it is not possible to get a true understanding of the problem, the conflict, or its basic forces without expanding the alternatives set. Unfortunately, collective action analysis does not improve our ability to formulate and introduce new, strikingly different proposals. But it does reveal compellingly the way in which traditional analyses suffer through the use of single-minded alternatives. For instance, along several axes in Figures 6.7 and 6.8 only a limited range of values are covered by the "basic six." Furthermore, each curve reflects an inadequate number of plotted points. Also, the graphs imply that each curve describes responses to a single issue "with all other issues held constant." Such is not the case. Thus, one must conclude that insufficient definition has been provided by the "basic six."

To address this problem for the study at hand, I would recommend further parametric analysis on the basic six alternatives. For example, using plans D2, A4, and/or B1, a single issue can be varied from 0.0 to 1.0 while all other axes were held constant. There are enough data available to permit a judicious selection of issues to parametrize. The results would provide a sounder definition of the conflict as initially

conceived. There should also be a systematic investigation of "growth" and "level of agricultural demand" as these issues relate to the collective action analysis.

These issues and alternatives are not available, however. So what has the study team provided with respect to the basic six?

- (1) Too few alternatives were considered to give an appropriate foundation for sound water resource planning in the Upper St. Johns;
- (2) The list of issues should be expanded at the very least to include alternative futures expressed as the desirable level of agricultural production for the basin. Each plan should be studied as it relates to each alternative future. Companion sections of the St. Johns study suggested very strongly that growth should not exceed the Soil Conservation Service projected levels for the year 2000;
- (3) Success increases as Melbourne water supply, water quality, and marsh preservation increase; success decreases as irrigation and "structural" flood control increase. This suggests a general undercurrent of environmental concern along with a rebuff of traditional water project ingredients. However, the environmental flavoring is moderate, since these issues receive 100 percent acceptability before they are driven to extreme limits;
- (4) There seems to be an identifiable distaste for irrigation storage *and* the consequences associated with it. Whenever an irrigation pool was included as an ingredient, that proposal received perceptively lower support than the same proposal without irrigation;
- (5) Table 6.11 shows that plans D2, A4, and B1 are "seemingly acceptable"; A3, B2, and A1 are "seemingly unacceptable." Since D2 is unreasonable at this point in time, A4 and B2 seem to be strong possibilities. These two plans suggest no irrigation pool. Any structures present would be used for flood control only, leaving the noninundated land for grazing, wildlife, or other undeveloped purposes. Developed recreation did not achieve a high level of visibility; undeveloped recreation, that associated with natural wild areas, was more visible by implication;
- (6) Given this flavoring for acceptable plans, it is not clear from the analysis whether the presence or absence of COE structures would be more acceptable;
- (7) A feeling for winners and losers can be gained from Table 6.11. If an entire group can be stereotyped by its leader, then those groups with dominant environmental concerns lose three times and

TABLE 6.11 A RANKING AND LEADERSHIP SUMMARY FOR
THE UPPER ST. JOHNS "BASIC SIX"

A RANKING BY PROBABILITY OF SUCCESS:

PLAN	PLURALITY ¹		MAJORITY ²		
	Soft Line	Hard Line	Soft Line	Hard Line	
D2	100	100	94	100	} SEEMINGLY ACCEPTABLE
A4*	100	97	93	82	
B1*	86	62	79	64	
A3**	64	1	83	4	} SEEMINGLY UNACCEPTABLE
B2**	62	20	79	30	
A1	15	0	0	0	

* Complete reservoir drawdown, no irrigation storage.

** Reservoir storage provided and used for irrigation water.

¹ One-way conflict.

² Two-way conflict.

A GENERALIZED LEADERSHIP PROFILE:

PLAN	PERCENT CHANCE			YES GROUP LEADER		NO GROUP LEADER	
	Yes	No	Tie				
D2	100	0	0	EPA*	WIN	Citrus	LOSE
A4	100	0	0	Melb. Coun. Pro	WIN	mixed**	LOSE
B1	86	8	6	Melb. Coun. Pro	WIN	Audubon*	LOSE
A3	64	23	13	Resid. Develop.	WIN	Game & Fish Comm*	LOSE
B2	62	0	38	FCD	WIN	Game & Fish Comm*	LOSE
A1	15	83	2	Cattlemen No. 1	LOSE	FCD	WIN

* Groups with dominant environmental concerns.

** Mixed: Citrus growers 61%, FCD 16%, COE 12%, Melbourne Council--
Con 8%, Audubon 2%, EPA 1%.

win once out of six proposed plans. The one win was for D2, an eliminated plan. Thus, environmental interests lose outright in 50 percent of the plans, basing this on their overt objections. This is not a contradiction with item (3). Most participants want a moderate level of environmental protection, but those who insist on higher levels of quality cannot muster sufficient support in their favor. Specific group behavior, in addition to leader responses, should be observed for more information on winners and losers; and

- (8) As mentioned earlier, substantial opposition to any of the proposed plans (except A1) cannot develop readily. This may result from the fact that only a narrow set of proposals have been considered. However, there is enough evidence to say that minority views tend to be submerged and that almost any plan proposed can be pushed through. This fact places an even heavier burden on those responsible for advancing the final recommendation. They can almost count on the fact that, if they recommend a marginal plan, corrective opposition to their action will not easily develop.

A Brief Recap

Such statements represent the type of results to be expected from collective action analyses at this intensity of introduction. All along, it was never expected that the approach would single out any proposal as best. In fact, the primary expectation was that such analysis would introduce a certain amount of organization into the confusion surrounding water resource conflicts. In my opinion this has been accomplished given the limitations imposed by the boundaries of the overall study.

With regard to the specific test problem, the collective analysis has advanced our understanding of the basic factors involved and the way in which they fit together. Yet, this advancement should be viewed only as an initial, clarifying step. The study has served primarily to isolate and define those features of the St. Johns problem which should be subjected to more detailed investigation.

It is not clear whether agency employees will find the material in this chapter (along with the larger study) to be helpful in their deliberations. If they were looking only for outside justification of their own preferred choices, then it is absolutely certain that Chapter VI will not serve this purpose. Quite the contrary, these pages have served to expose more complications and reduce the chances that a single proposal will emerge as the unqualified best. Thus, I would expect that finding such as these would make an agency employee's task much more difficult, especially a fair-minded employee. This difficulty would hopefully encourage him to look well beyond the boundaries of his agency's frame of reference into the collective decision environment where the answers lie, if they exist anywhere.

Conclusions, Insights, and Summaries

It is now time to look back over the last six chapters to see if they inspire any immediate words of wisdom. However, specific conclusions do not flow easily from research like this which parlayed concepts more than everyday problems. Lewis Coser [1956] has remarked that concepts are neither true nor false but useful or not useful. The same can be said for this research, and it should be judged in this light. But, before the final judgement can be made, various criteria which can be adopted for assessing usefulness should be listed:

- (1) It should make a decision maker's job simpler and easier;
- (2) It should provide decisive input to the decision process by narrowing down a set of proposals to a single best plan;

- (3) It should be able to filter out a small number of dominant proposals from a range of worthy plans;
- (4) It should define a range of worthy plans;
- (5) It should provide information to assist the decision process;
- (6) It should reveal the critical factors to be considered;
- (7) It should suggest appropriate criteria for assessing the critical elements;
- (8) It should describe the appropriate procedure for carrying out decision activities;
- (9) It should impart organization and consistency to our efforts, in conformation with natural and social laws;
- (10) It should reveal the manner in which our tacit assumptions interfere with proper planning behavior;
- (11) It should lead to the formulation of entirely new types of decision activities inconceivable in old frameworks of thought;
- (12) It should lead to a continual re-thinking, to the imposition of newly emerging more appropriate conditions of validity;
- (13) It should lay bare the criteria used to select courses of action.
- (14) It should leave one with the feeling that, although a best course of action was not readily apparent, all of the essential factors were consciously examined in good faith.

At this point I would naturally continue with my summary remarks using the numerous pages of notes accumulated over the months for this very purpose. However, much of it would be a repeat from earlier sections, and admittedly, my pen has run out of gas. So, I will terminate this dissertation with several observations.

Concepts and principles contained in these chapters cannot pay dividends unless they become an intimate ingredient in planning behavior and serve as guiding concepts for related independent studies.

Recent water resource investigations reveal an increased emphasis on "social" factors, and so, before we progress too far in this area these efforts must be related to a common set of fundamental laws. If not, there will not develop an acceptable degree of internal consistency.

The hardest part is still left. We do not have any means for the formulation of meaningful alternatives. This exigency brings up the requirement to develop and consider alternative futures, to accept the need to intervene purposively into socio-technical systems, to look beyond currently acceptable solution sets, etc. Thus, all available methodologies, including this one, must be considered to be primarily "evaluative." No guidance is provided, except simple-minded ones, to the formulation of alternatives.

To address these and other issues will require that all of us step beyond our existing abstractions or our progress will be modest at best. At the very least, those of us who call ourselves "water resource managers" must accept and use sociological and behavioral models with the same degree of ease and enthusiasm that we now associate with hydrologic or other more technical models.

APPENDIXES

APPENDIX A

THE BOW RIVER LINEAR PROGRAMMING MODEL

Introduction

Dorfman and Jacoby [1969, 1971] have already provided a full description of the Bow River LP model along with relevant technical, economic, and political details. Furthermore, mathematical programming techniques have been applied to this "standard river quality problem" for almost 10 years [Loucks *et al.*, 1967]. Thus, even though new articles may add another wrinkle, the essential ingredients of this type of analysis have become well established in the water management literature, and little would be accomplished by redeveloping the standard analysis here. Instead, this appendix sketches the LP formulation to give a feel for its sophistication and to allow others to duplicate its operation.

The Local Problem

Bow River Valley (Figure A.1) contains three waste discharge sources, two municipalities and a cannery, which often reduce dissolved oxygen to zero during critical summer periods. This deterioration in water quality has touched off a local controversy between "anti-pollution" and "waste discharge" forces over the appropriate use of

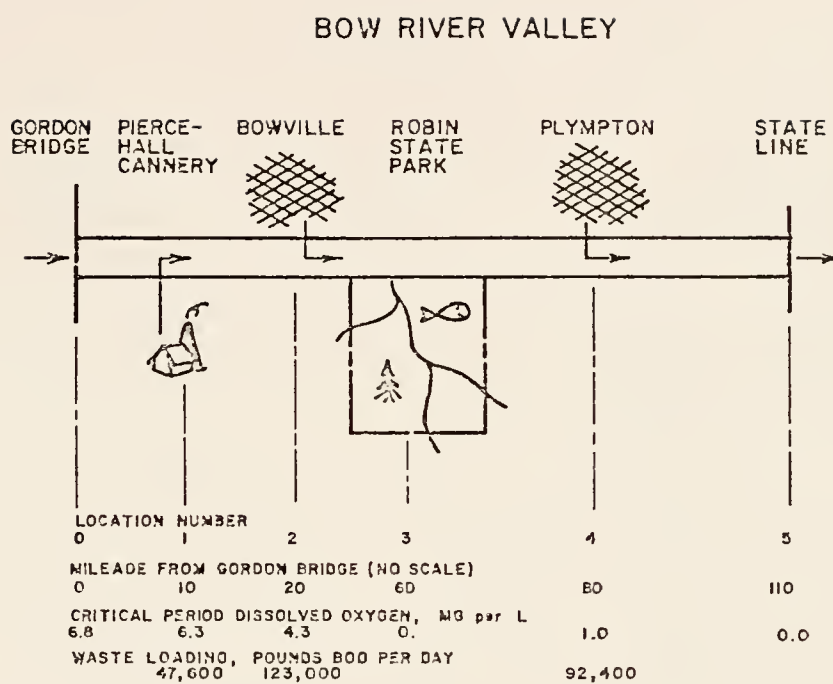


Figure A.1 A Schematic Diagram of the Bow River Problem

Bow River. Since additional waste treatment will be expensive, Bow Valley residents must agree on a level of waste treatment at each discharge point that will enhance overall water quality yet will strike a balance among the diverse value systems represented in the conflict.

The Technical-Economic Formulation

A single solution of the LP model, which also represents a single river basin *plan*, specifies a waste treatment vector $\underline{x}$, where x_i equals the %BOD removal at discharge point $i = 1, 2, 4$. Figure A.1 matches several important points along the river with their unique location numbers to simplify the following algebraic formulation. The Water Quality office of EPA has been identified with the number 6, as a device for including their presence.

Each basin plan has the potential for generating a vector of effects $\underline{e} = [\underline{c}, \underline{b}, \underline{q}, \underline{es}, \underline{sc}]$ similar in concept to those identified by impact statements of various types: hence $[\underline{x}] \cdot [\text{Impact Statement}] = [\underline{e}]$. For this problem the impact statement reduced to simple mathematical relationships which defined: c_i , the waste treatment cost associated with discharge point i ; b_i , the dollar benefit to discharge point i ; q_j , the resulting dissolved oxygen concentration at river location $j = 2, 3, 4, 5$; es , the percent protection for an endangered species of waterfowl; and sc , an overall river classification. The endangered waterfowl added an additional point of conflict to the local controversy and represents the primary modification of the original Dorfman and Jacoby model.

Waste treatment costs are determined by entering predetermined cost curves with treatment levels specified by a regional plan, thus, $\underline{c} = f(\underline{x})$. In linear programming language,

$$x_i = \sum_k x_{ik}$$

where,

x_i = %BOD removal at discharge point i ,

x_{ik} = %BOD removed at point i within linear segment k of its respective cost curve,

and,

$$c_i = \sum_k c_{ik} \cdot x_{ik} = g_i$$

where,

c_i = total treatment cost for discharge point i ,

c_{ik} = cost associated with linear segment k of the respective cost curve.

Table A.1 contains values for each c_{ik} used in this analysis.

As costs increase, however, benefits also increase because of enhanced water quality and the value local residents place on recreational opportunities. To simplify this component of the problem, Dorfman and Jacoby specified water quality benefits in terms of dollars per unit D.O. increase when below 5 mg/l and a different value when above 5 mg/l. Table A.2 contains values for $\underline{bf}$ as used in this model. If we define,

$$q_{j1} = \begin{cases} \text{amount of D.O. at location } j \text{ when } DO. \leq 5 \text{ mg/l} \\ q_{j1} = 5 \text{ mg/l, otherwise} \end{cases}$$

and,

q_{j2} = amount of D.O. in excess of 5 mg/l at location j ,

Table A.1 Treatment Cost Data for Bow River, c_{ik}

COST CURVE LINEAR SEGMENT	TREATMENT RANGE COVERED %	COSTS BOD REMOVAL IN EACH RANGE (\$ PER YEAR PER % BOD REMOVED)				WQO*
		CANNERY i=1	BOWVILLE i=2	PLYMPTON i=3		
k						i=4
1	30-80	1.60 E4	-	-		2.60 E4
2	80-90	2.70 E5	-	-		4.60 E5
3	90-95	1.20 E6	-	-		2.00 E6
1	30-80	-	9.80 E5	-		1.30 E6
2	80-90	-	1.70 E6	-		2.30 E6
3	90-95	-	2.46 E7	-		3.28 E7
1	30-80	-	-	8.20 E5		1.10 E6
2	80-90	-	-	1.40 E6		1.80 E6
3	90-95	-	-	2.06 E7		2.67 E7

* COSTS TO WQO ARE USED TO REPRESENT REGIONAL COSTS, THEREFORE

WQO COSTS = REGIONAL TREATMENT COST + GOVERNMENT SUBSIDY

Table A.2 Benefit Data for Bow River; $bf_{ij,1}$ and $bf_{ij,2}$
 (\$ per year per unit increase in D. O.)

	BOWVILLE			ST. PARK			PLYMPTON		
	j=2			j=3			j=4		
	D.O. RANGE			D.O. RANGE			D.O. RANGE		
	≤ 5	> 5		≤ 5	> 5		≤ 5	> 5	
BOWVILLE	i=2	1.00 E5	5.00 E4	3.30 E4	1.70 E4	---	---	---	
PLYMPTON	i=4	---	---	3.00 E4	1.00 E4	7.50 E4	2.50 E4		
WQO	i=6	1.00 E5	5.00 E4	9.45 E4	4.05 E4	7.50 E4	2.50 E4		

then,

$$b_i = \sum_j (bf_{ij,1} \cdot q_{j1} + bf_{ij,2} \cdot q_{j2}),$$

where,

b_i = gross benefits to discharge point,

$bf_{ij,1}$ = gross benefits to discharge point i per unit increase in D.O. at location j , if ≤ 5 mg/l,

$bf_{ij,2}$ = likewise, when D.O. at $j > 5$ mg/l.

After additional treatment capacity is installed, during critical periods dissolved oxygen concentrations at each important location will equal the D.O. at that location under existing conditions of primary treatment plus D.O. that, in effect, would be added by increased BOD removal upstream. Furthermore, BOD removal at each point upstream will affect conditions at each separate location downstream. The classical Streeter-Phelps formula was used in the following form to determine these relationships, which appear in Table A.3.

$$t_{ij} = -(1/F)(K_1/K_2 - K_1)(0.186) \left[\exp(-K_1 \cdot \Delta m \cdot 0.116 \times 10^{-4}/V) - \exp(-K_2 \cdot \Delta m \cdot 0.116 \times 10^{-4}/V) \right] (L_i)$$

where,

t_{ij} = D.O. increase at location j resulting from 100% BOD reduction at discharge point i ,

F = river flow rate, 800 cfs

Δm = distance between i and j , feet

V = stream velocity during critical period, 0.5 fps

Table A.3 D.O. Transport Coefficients for Bow River
 t_{ij} , mg/l per lb/day

FROM POLLUTER I, TO RECEIVER J				
	BOWVILLE j=2	ST. PARK j=3	PLYMPTON j=4	ST. LINE j=5
CANNERY i=1	2.1943	2.3895	1.5850	0.7568
BOWVILLE i=2	---	7.1955	5.0922	2.5336
PLYMPTON i=4	---	---	---	5.9228

All table entries should be multiplied by 10^{-5} .

K_1 = deaeration constant, 0.24 per day

K_2 = reaeration constant, 0.40 per day

L_i = BOD loading at discharge point i , lb/day.

Thus, D.O. at a point j after installation of treatment facilities can be represented as,

$$q_{j1} + q_{j2} = q_j(\text{Initial}) + \sum_{i < j} t_{ij}(x_i + 0.3)$$

where,

x_i = %BOD removal in addition to that removed by existing primary facilities.

These algebraic statements can be assembled into an operational LP representation shown in Figure A.2. By switching objective functions or by manipulating various bounds and RHS's, this model can generate a wide variety of plans and effects. Dorfman and Jacoby applied different weighting schemes to benefit terms in the objective function (xb_i) to suggest the existence of various political weightings. Under any mode of operation, however, this setup was intended to encourage flexibility and to enhance the generation of a range of possible plans that pass the tests of technical and financial feasibility and yet maintain optimality with respect to a specified criterion.

Figure A.2 Linear Programming Formulation for Bow River

OBJECTIVE FUNCTIONS:

VARIABLES:	x_{11}	x_{12}	x_{13}	x_{21}	x_{22}	x_{23}	x_{41}	x_{42}	x_{43}	q_{21}	q_{31}	q_{41}	q_{51}	q_{52}	q_{53}	q_{54}	q_{55}	q_{56}	q_{57}	q_{58}	q_{59}	q_{60}	q_{61}	q_{62}	q_{63}	q_{64}	q_{65}	q_{66}	q_{67}	q_{68}	q_{69}	q_{70}	q_{71}	q_{72}	q_{73}	q_{74}	q_{75}	q_{76}	q_{77}	q_{78}	q_{79}	q_{80}	q_{81}	q_{82}	q_{83}	q_{84}	q_{85}	q_{86}	q_{87}	q_{88}	q_{89}	q_{90}	q_{91}	q_{92}	q_{93}	q_{94}	q_{95}	q_{96}	q_{97}	q_{98}	q_{99}	q_{100}	q_{101}	q_{102}	q_{103}	q_{104}	q_{105}	q_{106}	q_{107}	q_{108}	q_{109}	q_{110}	q_{111}	q_{112}	q_{113}	q_{114}	q_{115}	q_{116}	q_{117}	q_{118}	q_{119}	q_{120}	q_{121}	q_{122}	q_{123}	q_{124}	q_{125}	q_{126}	q_{127}	q_{128}	q_{129}	q_{130}	q_{131}	q_{132}	q_{133}	q_{134}	q_{135}	q_{136}	q_{137}	q_{138}	q_{139}	q_{140}	q_{141}	q_{142}	q_{143}	q_{144}	q_{145}	q_{146}	q_{147}	q_{148}	q_{149}	q_{150}	q_{151}	q_{152}	q_{153}	q_{154}	q_{155}	q_{156}	q_{157}	q_{158}	q_{159}	q_{160}	q_{161}	q_{162}	q_{163}	q_{164}	q_{165}	q_{166}	q_{167}	q_{168}	q_{169}	q_{170}	q_{171}	q_{172}	q_{173}	q_{174}	q_{175}	q_{176}	q_{177}	q_{178}	q_{179}	q_{180}	q_{181}	q_{182}	q_{183}	q_{184}	q_{185}	q_{186}	q_{187}	q_{188}	q_{189}	q_{190}	q_{191}	q_{192}	q_{193}	q_{194}	q_{195}	q_{196}	q_{197}	q_{198}	q_{199}	q_{200}	q_{201}	q_{202}	q_{203}	q_{204}	q_{205}	q_{206}	q_{207}	q_{208}	q_{209}	q_{210}	q_{211}	q_{212}	q_{213}	q_{214}	q_{215}	q_{216}	q_{217}	q_{218}	q_{219}	q_{220}	q_{221}	q_{222}	q_{223}	q_{224}	q_{225}	q_{226}	q_{227}	q_{228}	q_{229}	q_{230}	q_{231}	q_{232}	q_{233}	q_{234}	q_{235}	q_{236}	q_{237}	q_{238}	q_{239}	q_{240}	q_{241}	q_{242}	q_{243}	q_{244}	q_{245}	q_{246}	q_{247}	q_{248}	q_{249}	q_{250}	q_{251}	q_{252}	q_{253}	q_{254}	q_{255}	q_{256}	q_{257}	q_{258}	q_{259}	q_{260}	q_{261}	q_{262}	q_{263}	q_{264}	q_{265}	q_{266}	q_{267}	q_{268}	q_{269}	q_{270}	q_{271}	q_{272}	q_{273}	q_{274}	q_{275}	q_{276}	q_{277}	q_{278}	q_{279}	q_{280}	q_{281}	q_{282}	q_{283}	q_{284}	q_{285}	q_{286}	q_{287}	q_{288}	q_{289}	q_{290}	q_{291}	q_{292}	q_{293}	q_{294}	q_{295}	q_{296}	q_{297}	q_{298}	q_{299}	q_{300}	q_{301}	q_{302}	q_{303}	q_{304}	q_{305}	q_{306}	q_{307}	q_{308}	q_{309}	q_{310}	q_{311}	q_{312}	q_{313}	q_{314}	q_{315}	q_{316}	q_{317}	q_{318}	q_{319}	q_{320}	q_{321}	q_{322}	q_{323}	q_{324}	q_{325}	q_{326}	q_{327}	q_{328}	q_{329}	q_{330}	q_{331}	q_{332}	q_{333}	q_{334}	q_{335}	q_{336}	q_{337}	q_{338}	q_{339}	q_{340}	q_{341}	q_{342}	q_{343}	q_{344}	q_{345}	q_{346}	q_{347}	q_{348}	q_{349}	q_{350}	q_{351}	q_{352}	q_{353}	q_{354}	q_{355}	q_{356}	q_{357}	q_{358}	q_{359}	q_{360}	q_{361}	q_{362}	q_{363}	q_{364}	q_{365}	q_{366}	q_{367}	q_{368}	q_{369}	q_{370}	q_{371}	q_{372}	q_{373}	q_{374}	q_{375}	q_{376}	q_{377}	q_{378}	q_{379}	q_{380}	q_{381}	q_{382}	q_{383}	q_{384}	q_{385}	q_{386}	q_{387}	q_{388}	q_{389}	q_{390}	q_{391}	q_{392}	q_{393}	q_{394}	q_{395}	q_{396}	q_{397}	q_{398}	q_{399}	q_{400}	q_{401}	q_{402}	q_{403}	q_{404}	q_{405}	q_{406}	q_{407}	q_{408}	q_{409}	q_{410}	q_{411}	q_{412}	q_{413}	q_{414}	q_{415}	q_{416}	q_{417}	q_{418}	q_{419}	q_{420}	q_{421}	q_{422}	q_{423}	q_{424}	q_{425}	q_{426}	q_{427}	q_{428}	q_{429}	q_{430}	q_{431}	q_{432}	q_{433}	q_{434}	q_{435}	q_{436}	q_{437}	q_{438}	q_{439}	q_{440}	q_{441}	q_{442}	q_{443}	q_{444}	q_{445}	q_{446}	q_{447}	q_{448}	q_{449}	q_{450}	q_{451}	q_{452}	q_{453}	q_{454}	q_{455}	q_{456}	q_{457}	q_{458}	q_{459}	q_{460}	q_{461}	q_{462}	q_{463}	q_{464}	q_{465}	q_{466}	q_{467}	q_{468}	q_{469}	q_{470}	q_{471}	q_{472}	q_{473}	q_{474}	q_{475}	q_{476}	q_{477}	q_{478}	q_{479}	q_{480}	q_{481}	q_{482}	q_{483}	q_{484}	q_{485}	q_{486}	q_{487}	q_{488}	q_{489}	q_{490}	q_{491}	q_{492}	q_{493}	q_{494}	q_{495}	q_{496}	q_{497}	q_{498}	q_{499}	q_{500}	q_{501}	q_{502}	q_{503}	q_{504}	q_{505}	q_{506}	q_{507}	q_{508}	q_{509}	q_{510}	q_{511}	q_{512}	q_{513}	q_{514}	q_{515}	q_{516}	q_{517}	q_{518}	q_{519}	q_{520}	q_{521}	q_{522}	q_{523}	q_{524}	q_{525}	q_{526}	q_{527}	q_{528}	q_{529}	q_{530}	q_{531}	q_{532}	q_{533}	q_{534}	q_{535}	q_{536}	q_{537}	q_{538}	q_{539}	q_{540}	q_{541}	q_{542}	q_{543}	q_{544}	q_{545}	q_{546}	q_{547}	q_{548}	q_{549}	q_{550}	q_{551}	q_{552}	q_{553}	q_{554}	q_{555}	q_{556}	q_{557}	q_{558}	q_{559}	q_{560}	q_{561}	q_{562}	q_{563}	q_{564}	q_{565}	q_{566}	q_{567}	q_{568}	q_{569}	q_{570}	q_{571}	q_{572}	q_{573}	q_{574}	q_{575}	q_{576}	q_{577}	q_{578}	q_{579}	q_{580}	q_{581}	q_{582}	q_{583}	q_{584}	q_{585}	q_{586}	q_{587}	q_{588}	q_{589}	q_{590}	q_{591}	q_{592}	q_{593}	q_{594}	q_{595}	q_{596}	q_{597}	q_{598}	q_{599}	q_{600}	q_{601}	q_{602}	q_{603}	q_{604}	q_{605}	q_{606}	q_{607}	q_{608}	q_{609}	q_{610}	q_{611}	q_{612}	q_{613}	q_{614}	q_{615}	q_{616}	q_{617}	q_{618}	q_{619}	q_{620}	q_{621}	q_{622}	q_{623}	q_{624}	q_{625}	q_{626}	q_{627}	q_{628}	q_{629}	q_{630}	q_{631}	q_{632}	q_{633}	q_{634}	q_{635}	q_{636}	q_{637}	q_{638}	q_{639}	q_{640}	q_{641}	q_{642}	q_{643}	q_{644}	q_{645}	q_{646}	q_{647}	q_{648}	q_{649}	q_{650}	q_{651}	q_{652}	q_{653}	q_{654}	q_{655}	q_{656}	q_{657}	q_{658}	q_{659}	q_{660}	q_{661}	q_{662}	q_{663}	q_{664}	q_{665}	q_{666}	q_{667}	q_{668}	q_{669}	q_{670}	q_{671}	q_{672}	q_{673}	q_{674}	q_{675}	q_{676}	q_{677}	q_{678}	q_{679}	q_{680}	q_{681}	q_{682}	q_{683}	q_{684}	q_{685}	q_{686}	q_{687}	q_{688}	q_{689}	q_{690}	q_{691}	q_{692}	q_{693}	q_{694}	q_{695}	q_{696}	q_{697}	q_{698}	q_{699}	q_{700}	q_{701}	q_{702}	q_{703}	q_{704}	q_{705}	q_{706}	q_{707}	q_{708}	q_{709}	q_{710}	q_{711}	q_{712}	q_{713}	q_{714}	q_{715}	q_{716}	q_{717}	q_{718}	q_{719}	q_{720}	q_{721}	q_{722}	q_{723}	q_{724}	q_{725}	q_{726}	q_{727}	q_{728}	q_{729}	q_{730}	q_{731}	q_{732}	q_{733}	q_{734}	q_{735}	q_{736}	q_{737}	q_{738}	q_{739}	q_{740}	q_{741}	q_{742}	q_{743}	q_{744}	q_{745}	q_{746}	q_{747}	q_{748}	q_{749}	q_{750}	q_{751}	q_{752}	q_{753}	q_{754}	q_{755}	q_{756}	q_{757}	q_{758}	q_{759}	q_{760}	q_{761}	q_{762}	q_{763}	q_{764}	q_{765}	q_{766}	q_{767}	q_{768}	q_{769}	q_{770}	q_{771}	q_{772}	q_{773}	q_{774}	q_{775}	q_{776}	q_{777}	q_{778}	q_{779}	q_{780}	q_{781}	q_{782}	q_{783}	q_{784}	q_{785}	q_{786}	q_{787}	q_{788}	q_{789}	q_{790}	q_{791}	q_{792}	q_{793}	q_{794}	q_{795}	q_{796}	q_{797}	q_{798}	q_{799}	q_{800}	q_{801}	q_{802}	q_{803}	q_{804}	q_{805}	q_{806}	q_{807}	q_{808}	q_{809}	q_{810}	q_{811}	q_{812}	q_{813}	q_{814}	q_{815}	q_{816}	q_{817}	q_{818}	q_{819}	q_{820}	q_{821}	q_{822}	q_{823}	q_{824}	q_{825}	q_{826}	q_{827}	q_{828}	q_{829}	q_{830}	q_{831}	q_{832}	q_{833}	q_{834}	q_{835}	q_{836}	q_{837}	q_{838}	q_{839}	q_{840}	q_{841}	q_{842}	q_{843}	q_{844}	q_{845}	q_{846}	q_{847}	q_{848}	q_{849}	q_{850}	q_{851}	q_{852}	q_{853}	q_{854}	q_{855}	q_{856}	q_{857}	q_{858}	q_{859}	q_{860}	q_{861}	q_{862}	q_{863}	q_{864}	q_{865}	q_{866}	q_{867}	q_{868}	q_{869}	q_{870}	q_{871}	q_{872}	q_{873}	q_{874}	q_{875}	q_{876}	q_{877}	q_{878}	q_{879}	q_{880}	q_{881}	q_{882}	q_{883}	q_{884}	q_{885}	q_{886}	q_{887}	q_{888}	q_{889}	q_{890}	q_{891}	q_{892}	q_{893}	q_{894}	q_{895}	q_{896}	q_{897}	q_{898}	q_{899}	q_{900}	q_{901}	q_{902}	q_{903}	q_{904}	q_{905}	q_{906}	q_{907}	q_{908}	q_{909}	q_{910}	q_{911}	q_{912}	q_{913}	q_{914}	q_{915}	q_{916}	q_{917}	q_{918}	q_{919}	q_{920}	q_{921}	q_{922}	q_{923}	q_{924}	q_{925}	q_{926}	q_{927}
------------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

BOUND: $x_{11} \leq 0.50$, $x_{12} \leq 0.10$, $x_{13} \leq 0.05$, $q_{11} \leq 5.0$, $q_{12} \leq 2.5$, $q_{13} + q_{14} \leq 7.5$.

APPENDIX B

THE COLLECTIVE ACTION SIMULATION MODEL

The political simulation model developed by Bulkley and McLaughlin [1966], served as the foundation for the collective action simulation model applied in Chapters V and VI. Its main purpose was to illustrate and accent features of the more encompassing collective action approach from Chapters II, III, and IV. Although no substantive modifications were made for their models, those changes that were made are described below.

Appendix B contains only selected technical details relative to CASM. *It is not a user's guide*, even though a listing of the source program appears at the end of the appendix. Instead, those calculations which are central to the operation of CASM are defined so that the interested reader can work his way through the model's logic, if desired.

CASM requires the following input information:

- (1) n participant groups, $i = 1, 2, \dots, n$
- (2) m issues or components, $j = 1, 2, \dots, m$
- (3) For each participant group, i --
 - (a) A salience ranking of his three most preferred issues,
IBEST1 = first preferred issue = 1, 2, ..., m
IBEST2 = second ...
IBEST3 = thirs ...

- (b) A power coefficient, $0 \leq \text{POWCOF}_i \leq 1$
 - (c) Ideal goals for each issue, $0 \leq \text{GOALS}_{ij} \leq 1$
 - (d) Aspiration level for each issue, $0 \leq \text{TVYES}_{ij} \leq 1$
 - (e) Exasperation level for each issue, $0 \leq \text{TVNO}_{ij} \leq 1$
 - (f) Ideological position toward each issue, $-1.0 \leq \text{POZMAT}_{ij} \leq +1.0$
- (4) A plan, described by its m "scaled" components, $0 \leq \text{SHARE}_j \leq 1$.

Illustration of Major CASM Operations

First, to provide a means for making decisions in uncertain situations, subroutine NRAN generates a random number, which is normally distributed with mean = 0 and variance = 1. This random number generator can serve any number of situations. For instance, should an interest group be unsure whether to vote "yes" or "no," NRAN will decide "no" if the random number is less than zero and "yes" if greater than zero.

The logic of the model follows these basic steps:

- (1) Given a single plan, SHARE_j ($j = 1, 2, \dots, \text{and } m$), each group decides to vote "yes" or "no" based on his personal goals structure;
- (2) A leader is selected for each side;
- (3) Participants drop out of either coalition if an ideological conflict exists between themselves and the leader; and
- (4) Based on the power or votes within each coalition, the plan will pass, fail, or be tied/stalelated.

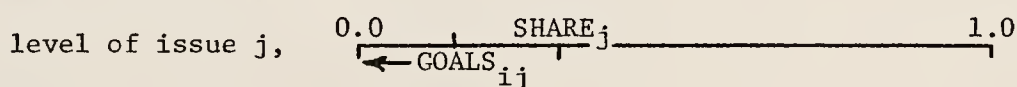
To Decide "Yes" or "No"

Each issue is scaled from 0.0 to 1.0. Each group has an ideal goal for each issue. Only two types of preference functions were considered, linear positively sloped and linear negatively sloped. This can be diagrammed as follows for any issue j :

Linear positively sloped--



Linear negatively sloped--



Given his ideal goals and the contribution provided by the plan in question, $SHARE_j$, we can calculate the degree of satisfaction (dissatisfaction) that the plan gives to each participant.

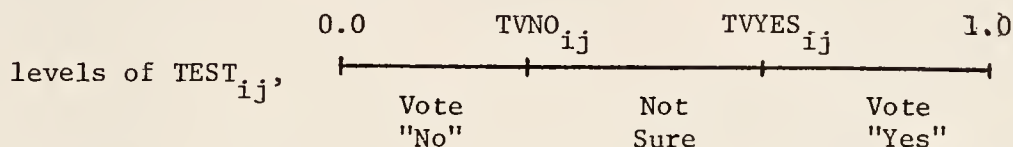
$$TEST_{ij} = SHARE_j / GOALS_{ij} \quad \text{for positively sloped preference,}$$

$$TEST_{ij} = (1 - SHARE_j) / (1 - GOALS_{ij}) \quad \text{for negatively sloped preference.}$$

If test exceeded 1.0, the model set it equal to 1.01 as a flag.

$TEST_{ij}$ can be interpreted as the percent satisfaction (dissatisfaction) provided to participant i along issue j by the plan in question. If $TEST_{ij} = 1.0$, it is clear that group i would vote "yes" since his ideal goals are realized. However, he will also vote "yes" if $TEST$ is somewhat less than 1.0. $TVYES_{ij}$ specifies that percent satisfaction above which the group will still vote "yes." Also, there is some level of $TEST$ below which the project does not measure up even to a group's bare minimum goal requirements. $TVNO_{ij}$ specifies that percent satisfaction which is so low that a group will unequivocally vote "no."

Between these two threshold levels there is a grey area in which he cannot decide whether he is for or against. NRAN generates a random number to solve this dilemma.



Each plan has m issues. Each participant thus has m separate $TEST_j$, $TVYES_j$, and $TVNO_j$. The problem then becomes one of determining how a group behaves on the basis of this set of criteria. In Bow Valley, a group looks at only one issue, his most preferred ($IBESTI$), and votes for or against based on this singular consideration. In the Upper St. Johns, a group looks at his top three issues and decides on this expanded basis. Here, the decision pattern becomes more complicated. The flowchart in Figure B.1 describes the thought process assumed for each group i when considering three separate issues, instead of only one.

$TEST1_i = TEST_{i, IBEST1} = \text{TEST for most preferred issue}$

$TEST2_i = \text{second ...}$

$TEST3_i = \text{third ...}$

The same notation holds for $TVYES_{1,2,3}$ and $TVNO_{1,2,3}$.

To Select a Leader

A leader is chosen for each side on the basis of his power and the degree to which the plan satisfies his goals structure. This permits those most affected, both positively and negatively, to have an opportunity for leadership. However, even though seriously affected,

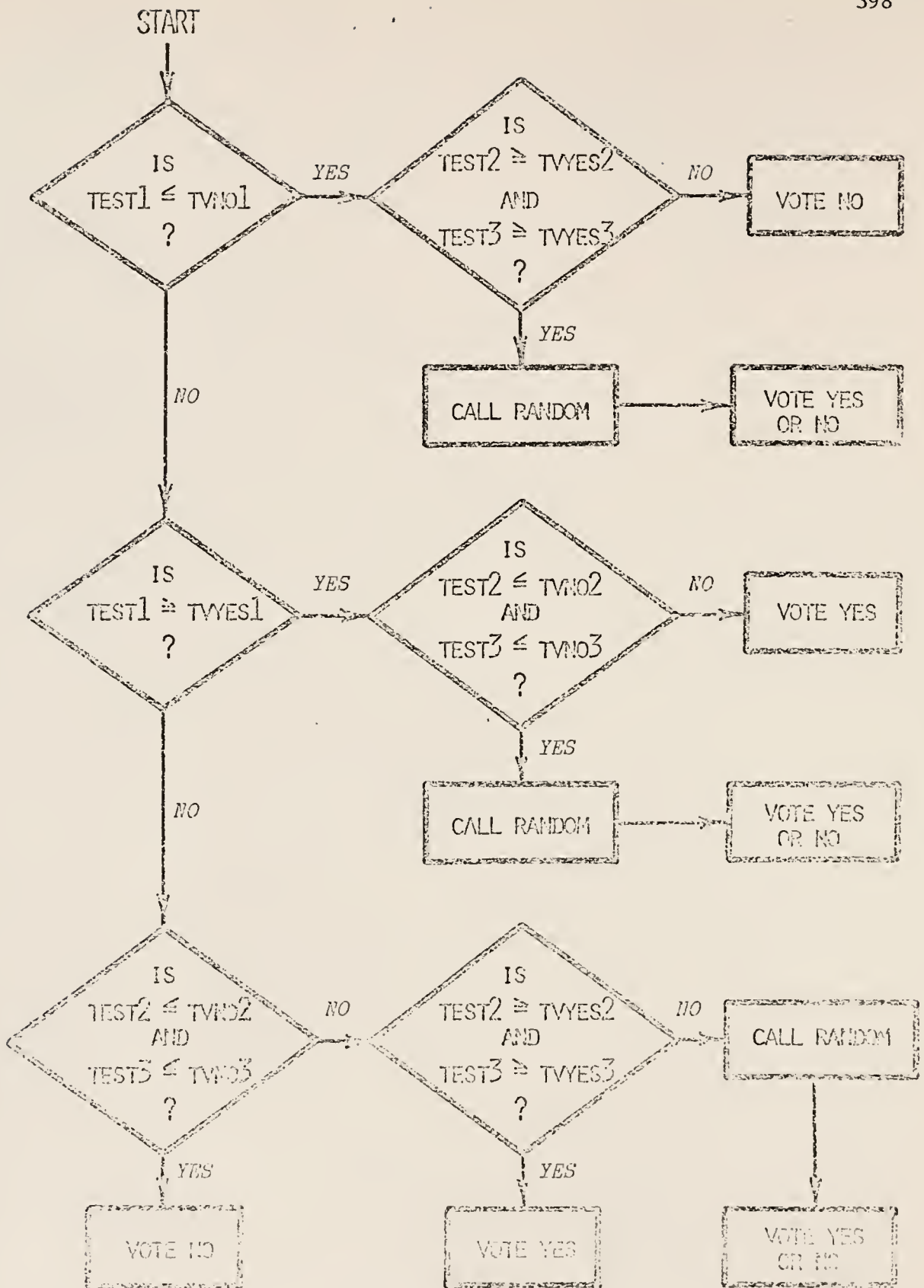


Figure B.1 Pattern of Deliberation for Each Group Considering Three Separate Issues

a person may not possess sufficient power to become an active leader. Thus, a leader is chosen on the basis of a weighted combination of power and satisfaction (dissatisfaction).

Leadership index for "yes" group--

$$CRITYS_i = 0.35*POWCOF_i + 0.35*TEST1_i + 0.20*TEST2_i + 0.10*TEST3_i.$$

Leadership index for "no" group--

Given these levels of dissatisfaction,

$$PSEUD1_i = 1 - TEST1_i$$

$$PSEUD2_i = 1 - TEST2_i$$

$$PSEUD3_i = 1 - TEST3_i$$

$$CRITNO_i = 0.35*POWCOF_i + 0.35*PSEUD1_i + 0.20*PSEUD2_i + 0.10*PSEUD3_i.$$

Given leadership indices for each member of both sides, the member with the highest index is chosen to be the leader. His primary function is to serve as a focal point for the process of coalition solidification.

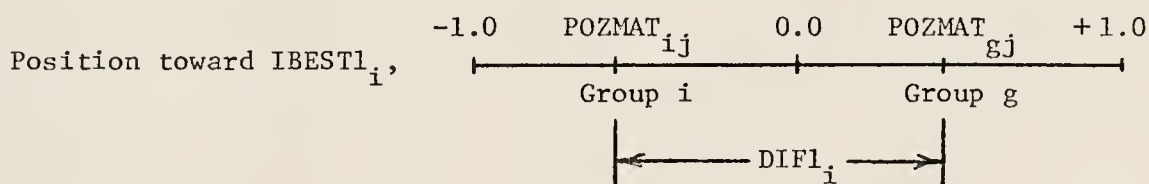
To Define a Conflict Relationship

Many factors can serve as a source of conflict in this type of decision situation; for example, differences in ideological positions, conflicting objectives, personal dislikes, plus many others. For CASM, conflict between participants was defined by their ideological positions toward each project issue. Such positions were scaled from -1.0 most negative to +1.0 most positive; a neutral or indifferent feeling toward an issue was scaled as 0.0. Using, then, the notion of

psychological or ideological "distance," a potential conflict between two members could be related to the difference between their ideological positions.

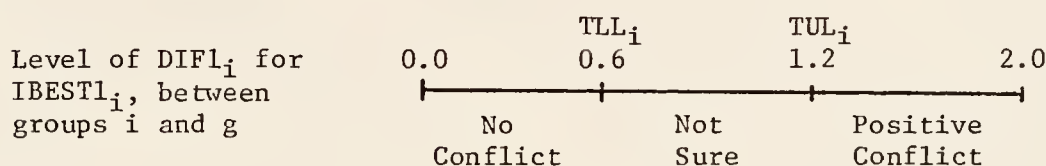
Several more sophisticated "distance" techniques are available, however, a simpler scheme was employed by CASM. First, it was necessary to define one-way and two-way conflicts. For instance, member i could have been in conflict with his group's leader, while the leader was not in conflict with member i .

As an illustration we can identify those members in potential conflict with participant i . Such conflict is based on the preferred project components of member i ($IBEST1_i$, $IBEST2_i$, $IBEST3_i$, ...), using as many components as the analyst desires. Bow Valley based conflict on a singular consideration, $IBEST1_i$; the St. Johns version expanded the analysis to include the top three components of each group. The sketch below illustrates the logic involved:



For this single issue, $IBEST1_i$, the distance separating i from g can range from 0.0 to 2.0. If the distance equals 0.0, i and g share ideological positions and would not experience conflict; if the distance equals 2.0, i and g are as far apart ideologically as they can be and thus will be in conflict. The problem then becomes one of determining where the cutoff should be for conflict and agreement.

In Bow Valley, potential conflict was identified by a single issue, $IBEST1_i$. Actual conflict was presumed to occur if $DIF1_i$ equaled or exceeded "the upper limit," $TUL_i = 1.2$. Unequivocal agreement occurred if $DIF1_i$ equaled or was less than "the lower limit," $TLL_i = 0.6$. TUL_i and TLL_i were constant for all the $(m)(m-1)$ possible pairs of relationships. If $DIF1_i$ fell between 0.6 and 1.2, one could express some uncertainty about the existence of conflict between the two. In this case, NRAN generated a random number to resolve the uncertainty.



Again, there are $(m)(m-1)$ values of $DIF1_i$. The St. Johns CASM extended the analysis of conflict to include a member's top three issues. This gives $(m)(m-1)$ values of $DIF2_i$ and $DIF3_i$ also. In this case, it was necessary to express $DIF1_i$, $DIF2_i$, and $DIF3_i$ as a single composite index of conflict:

$$COFDIF_{ig} = 0.65^* DIF1_i + 0.25^* DIF2_i + 0.10^* DIF3_i.$$

Instead of holding TUL and TLL constant in the St. Johns problem, these values were estimated for each pair of participants. Thus, there were $(m)(m-1)$ values of both TUL and TLL , based on information obtained from the field interviews. For each relationship between groups i and g (different from g and i), $COFDIF_{ig}$ was compared to TUL_{ig} and TLL_{ig} for the final definition of conflict.

To Determine the Fate of a Given Plan

Plans were presumed to stand or fall on the basis of two criteria, the summation of power or votes. After the coalition process terminated, that is, after conflict relationships thinned out both the "yes" and "no" groups, power and votes could be compared. For each side, (1) the power coefficients of each member were summed and (2) the number of members remaining were counted. In the case of either plurality, majority, or two-thirds requirements, the fate of any plan could be determined by comparing power and/or votes for each side.

Formulation of an Operational Model

This section describes the manner in which CASM's major operations were assembled into a working package. First, since NRAN was employed in various situations, any single outcome of the model will reflect a degree of uncertainty. Middle-of-the-road groups might vote for or against; grey areas of conflict might fall into either positive conflict or no conflict classifications. Thus, any single outcome might or might not contain appropriate information. To correct for this, the coalition process was performed 100 separate times for each submitted plan. In this way, the overall outcome and the behavior of all participants could be expressed in probabilistic terms, which is also a more appropriate way of describing future outcomes anyhow.

To convert the major operations into an efficient model, the source program contains a single executive routine which manages a number of subroutines. In this way, it was simple and efficient to

"call" any specific procedure (like "select a leader") in any required pattern. Also, in the event that other types of processes were to be investigated, only a minimum of effort would be required to reassemble the "building blocks" into some desired form.

CASM uses the following sequence of operations:

- (1) CALL INPUT--to read in basic data;
- (2) CALL PREFER--to calculate ideological differences between $(m)(m-1)$ pairs of participants;
- (3) CALL POWER--to calculate power coefficients;
- (4) Submit a plan to the CASM arena, $SHARE_j$;
- (5) CALL DECIDE--to calculate testing criteria for each member, $TEST_{ij}$;
- (6) Require arena to respond to plan 100 separate times:
 - (a) CALL FOE--to identify conflict relationships;
 - (b) CALL LEADER--to divide members into "yes" and "no" groups and to select a leader for each side;
 - (c) CALL ALIGN--to thin down groups on the basis of defined conflicts and to check whether the plan passes, fails, or ties/stalemates;
- (7) CALL REPORT--to generate a written summary of the 100 cycles for the given plan;
- (8) CALL SAVE--to store results for each plan;
- (9) CALL SWITCH--to rank all plans submitted according to some pre-specified criteria;
- (10) CALL OUTPUT--to generate a written summary for all plans considered.

The remainder of the appendix contains a listing of CASM as it was applied to the Upper St. Johns problem.

SOURCE PROGRAM LISTING
COLLECTIVE ACTION SIMULATION MODEL
CASM

```

//BARGAIN JOB (1006,3408,180,20,0000),'MCLAUGHLIN ',CLASS=S
//PASSWORD      1, BYTECNE
// EXEC F4G6XS
//PORT.SYSIN DC *
COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNO,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5NPOW,NTIES,PCWCCF(14),PCWIG(14),COFDIF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SOPNO,SDPYES,RELNO,RELAYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLD,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*ASTALM,IGNSM(14),IGYSM(14)
600 FORMAT('1',10X,'NEW SEED FOR NRAN= ',I30)
601 FORMAT('1','THE FOLLOWING REPRESENTS A RANKING OF PLANS BY POSSIBI
1LITY OF SUCCESS')
602 FORMAT('1','THE FOLLOWING OUTPUT REPRESENTS A TABULATION OF RESULT
1S FOR ALL PLANS CONSIDERED',/)
CALL INPUT
CALL PREFER
CALL POWER
CO 1 LINE=1,NPLAN
IPLAN=LIST(LINE,1)
C ERASE CONTROLS CERTAIN OUTPUT ON LONG JOBSO ERASE=0. MEANS NONE
ERASE=1.
IF(LINE .GT.1.AND.LINE .LT.NPLAN) ERASE=0.
C INTRODUCE NEW PLAN
CO 2 J=2,NPLUS
SHARE(J-1)=0.

```

```

      SHARE(J-1)=PLAN(LINE,J)
      2 CONTINUE
      C BEGIN BARGAINING ON NEW PLAN
      CALL DECIDE
      DO 3 NCYCLE=1,LCOPS
      CALL FCE
      CALL LEADER
      CALL ALIGN
      3 CONTINUE
      C GENERATE A VOTING SUMMARY FOR THIS ROUND
      CALL REPORT
      C RECCRD RESULTS FOR ALL PLANS CONSIDERED
      CALL SAVE
      1 CONTINUE
      WRITE(6,602)
      CALL CUTPUT
      C PARTIALLY RANK PLANS BY POSSIBILITY OF SUCCESS
      DO 4 K=1,NPLAN
      DO 4 LINE =1,NLESS
      IF(LIST(LINE ,2).LT.LIST(LINE +1,2)) CALL SWITCH
      4 CONTINUE
      WRITE(6,601)
      C TABULATE RESULTS OF BARGAINING AND RANKING
      CALL CUTPUT
      WRITE(6,600) IX
      STCP
      ENC
      SUBROUTINE INPUT
      COMMON DECRL,ICONMX(14,14),IGFAIL(14),
      2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
      3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
      4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NUGRP(14),NPASS,
      5APGW,NTIES,POWCCF(14),POWIG(14),COFDIF(14,14),
      6PCWNC,POWSUM,POZMAT(14,8),POWYES,

```

```

7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNO(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNO(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELNO,RELAYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLD,HOLD,NLESS,IPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
503 FORMAT(14I2)
507 FORMAT(8F4.2)
508 FORMAT(14,8F4.2)
510 FORMAT(14F5.1)
511 FORMAT(8F5.1)
600 FORMAT(1X,'BEGIN DATA INPUT AND DISPLAY ',//)
601 FORMAT(1)
602 FORMAT(1X,'IBEST1, PREFERRED PROJECT ATTRIBUTE')
604 FORMAT(1X,'SHARE, PROPOSED ALLOCATION TO PROJECT ATTRIBUTES')
606 FORMAT(1X,'POWIG, RAW POWER OF EACH INTEREST GROUP')
607 FORMAT(1X,'POZMAT, POSITION MATRIX')
612 FORMAT(1X,'WGOALS, GOALS FOR WATER ALLOCATION')
613 FORMAT(1X,'TVNO, THRESHOLD VALUES FOR OPPOSITION ')
614 FORMAT(1X,'TVYES, THRESHOLD VALUES FOR CONCURRENCE ')
615 FORMAT(//,1X,'ALL DATA HAS BEEN READ AND DISPLAYED ')
616 FORMAT('0')
617 FORMAT(2X,'INTEREST GROUPS',48X,'QUANTIFIED PROJECT ISSUES')
618 FORMAT(T1,' 1. CATTLEMEN NO. 1',T60,' 1. WATER SUPPLY FOR MELBOUR
1NE',/T1,' 2. CATTLEMEN NO. 2',T60,' 2. WATER FOR IRRIGATION',/T1,'
3' 3. CITRUS GROWERS', T60,' 3. AGRICULTURAL PRODUCTION',/T1,'
3 4. RESIDENTIAL DEVELOPERS',T60,' 4. RESIDENTIAL DEVELOPMENT',/T1
4,' 5. GAME + FISH COMM.',T60,' 5. WATER QUALITY',/T1,' 6. ENVIRO
6NMENTAL PROTECTION AGENCY',T60,' 6. MARSHLAND, FISH + WILDLIFE PRE
7SERVATION',/T1,' 7. AUDUBON SOCIETY',T60,' 7. NO. OF RECREATIONAL
8 CPPCRTUNITIES',/T1,' 8. LEAGUE OF WOMEN VOTERS',T60,' 8. DEGREE
9OF FLOOD PROTECTION' /,T1,' 9. BREVARD COUNTY COMMISSIONERS',/T1,

```

```

1. 10. FLOOD CONTROL DISTRICT',,T1,' 11. CORPS OF ENGINEERS',,T1,'
212. MELBOURNE CITY COUNCIL PRO' /,T1,' 13. MELBOURNE CITY COUNCIL
3CCN' /,T1,' 14. CONCERNED CITIZENS PRO')
620 FORMAT(10X, 8F5.2)
622 FORMAT(10X, 8F5.2)
626 FORMAT(10X, 14I2)
627 FORMAT(10X, 14F5.1)
628 FORMAT(1X,
1
1,/)
629 FORMAT(1X,'PLAN      MELB      IRRI      AGR      RESID      WATER      MARSH
1REC      FLOOD')
630 FORMAT(1X,'NUM.      WTR      WTR      PROD      DEV      QUAL      F+W
1CPP      PROT')
631 FORMAT(1X,I3,8(4X,F4.2))
632 FORMAT(1X,'IBEST2, SECOND FAVORITE PROJECT ATTRIBUTE')
633 FORMAT(1X,'IBEST3, THIRC FAVORITE PROJECT ATTRIBUTE')
634 FORMAT(1X,'TLL MATRIX,THE POSITION DIFFERENCE FOR NO CONFLICT')
635 FORMAT(1X,'TUL MATRIX,THE POSITION DIFFERENCE FOR CONFLICT')
636 FORMAT(10X,14F5.1)
640 FORMAT(1X,'***** ALL INTEREST GROUPS SHARE CONCILIATORY MOOD
1. THEY ARE WILLING TO MODIFY THEIR POSITIONS TO A SOFT LINE ',/
2)
641 FORMAT(1X,'***** THE INTEREST GROUPS ARE NOT VERY CONCILIATO
1RY. THEY HAVE TAKEN A HARD LINE AND ARE UNWILLING TO CHANGE',/)
642 FORMAT(1X,'***** ONE-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS SUFFICIENT FOR IGS TO REFUSE TO JOIN',/)
643 FORMAT(1X,'***** TWO-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS REQUIRED BEFORE IGS REFUSE TO JOIN',/)
644 FORMAT(1X,'***** NO CONFLICT CONSIDERED IN COALITION FORMATI
1CN. THUS NO IG CAN ABSTAIN AND A MAJORITY IS REQUIRED',/)
645 FORMAT(1X,'***** DECISION RULES REQUIRE A PLURALITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',/)
646 FORMAT(1X,'***** DECISION RULES REQUIRE A MAJORITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',/)

```



```

647 FORMAT(1X,'***** DECISION RULES REQUIRE TWO-THIRDS OF THE PO
1WER FOR A PLAN TO BE PASSED OR DEFEATED',/)
648 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
ICTE',/,'1X,'***** ONLY A PLURALITY OF VOTES IS REQUIRED FOR A
2 PLAN TO BE PASSED OR DEFEATED',/)
649 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
ICTE',/,'1X,'***** A MAJORITY OF VOTES IS NECESSARY FOR A PLAN
2 TO BE PASSED OR DEFEATED',/)
650 FORMAT(1X,'OPTIONS IN EFFECT DURING THIS RUN ARE AS FOLLOWS',/)
651 FORMAT(1X,'STANCE= ',F4.2)
652 FORMAT(1X,'COACT= ',F4.2)
653 FORMAT(1X,'DECRUL= ',F4.2)
      IX=
      NPLAN=16
      NLESS=NPLAN-1
      N=14
      M=8
      NPLUS=M+1
      LOOPS=100
      ASSIGN VALUES TO IG AND IATTR
      DO 5 I=1,N
      IG(I)=I
5 CONTINUE
      DO 6 J=1,M
      IATTR(J)=J
6 CONTINUE
      DO 1 I=1,14
      DO 1 J=1,8
      DO 1 L=1,2
      IBEST1(I)=0
      IBEST2(I)=0
      IBEST3(I)=0
      PCWIG(I)=0.
      SHARE(J)=0.

```

542276707

```

POZMAT(I,J)=0.0
GCALS(I,J,L)=0.
TVNC(I,J)=0.
TVYES(I,J)=0.
1 CONTINUE
DO 10 I=1,14
DO 10 J=1,14
TLL(I,J)=0.
TUL(I,J)=0.
10 CONTINUE
DO 2 I=1,14
DO 2 J=1,8
GCALS(I,J,2)=1.0
2 CONTINUE
GCALS(1,4,2)=-1.
GCALS(1,7,2)=-1.
GCALS(1,8,2)=-1.
GCALS(2,4,2)=-1.
GCALS(2,7,2)=-1.
GCALS(3,4,2)=-1.
GCALS(3,7,2)=-1.
GCALS(5,2,2)=-1.
GCALS(5,3,2)=-1.
GCALS(5,4,2)=-1.
GCALS(6,2,2)=-1.
GCALS(7,2,2)=-1.
GCALS(7,3,2)=-1.
GCALS(7,4,2)=-1.
GCALS(8,2,2)=-1.
GCALS(8,3,2)=-1.
GCALS(8,4,2)=-1.
GCALS(13,2,2)=-1.
GCALS(13,3,2)=-1.
GCALS(13,4,2)=-1.

```

```

WRITE(6,600)
  READ(5,503) (IBEST1(I), I=1,N)
  READ(5,503) (IBEST2(I), I=1,N)
  READ(5,503) (IBEST3(I), I=1,N)
  READ(5,510) (POWIG(I), I=1,N)
  READ(5,511) ((POZMAT(I,J), J=1,M), I=1,N)
  READ(5,507) ((GOALS(I,J,1), J=1,M), I=1,N)
  READ(5,507) COACT
  READ(5,507) DECRUL
  READ(5,507) STANCE
  READ(5,507) ((TVYES(I,J), J=1,M), I=1,N)
  READ(5,507) ((TVNO(I,J), J=1,M), I=1,N)
  READ(5,510) ((TLL(I,J), J=1,N), I=1,N)
  READ(5,510) ((TUL(I,J), J=1,N), I=1,N)
  CC 4 I=1,30
  READ(5,508) LIST(I,1), (PLAN(I,J), J=2,9)
4  CCNTINUE
  WRITE(6,602)
  WRITE(6,626) (IBEST1(I), I=1,N)
  WRITE(6,632)
  WRITE(6,626) (IBEST2(I), I=1,N)
  WRITE(6,633)
  WRITE(6,626) (IBEST3(I), I=1,N)
  WRITE(6,604)
  WRITE(6,607)
  WRITE(6,620) ((POZMAT(I,J), J=1,M), I=1,N)
  WRITE(6,606)
  WRITE(6,627) (POWIG(I), I=1,N)
  WRITE(6,612)
  WRITE(6,622) ((GOALS(I,J,1), J=1,M), I=1,N)
  WRITE(6,622) ((GOALS(I,J,2), J=1,M), I=1,N)
  WRITE(6,613)
  WRITE(6,620) ((TVNO(I,J), J=1,M), I=1,N)
  WRITE(6,614)

```

```

WRITE(6,620)((TVYES(I,J),J=1,M),I=1,N)
WRITE(6,634)
WRITE(6,636)((TLL(I,J),J=1,N),I=1,N)
WRITE(6,635)
WRITE(6,636)((TUL(I,J),J=1,N),I=1,N)
WRITE(6,601)
WRITE(6,628)
WRITE(6,629)
WRITE(6,630)
WRITE(6,628)
DO 3 I=1,30
WRITE(6,631) LIST(I,1),(PLAN(I,J),J=2,NPLUS)
3 CONTINUE
WRITE(6,628)
WRITE(6,651) STANCE
WRITE(6,652) COACT
WRITE(6,653) DECRUL
WRITE(6,615)
WRITE(6,616)
WRITE(6,650)
IF(STANCE.EQ.0.) WRITE(6,640)
IF(STANCE.EQ.1.) WRITE(6,641)
IF(COACT.EQ.1.) WRITE(6,642)
IF(COACT.EQ.2.) WRITE(6,643)
IF(COACT.EQ.3.) WRITE(6,644)
IF(DECRUL.EQ.1.) WRITE(6,645)
IF(DECRUL.EQ.2.) WRITE(6,646)
IF(DECRUL.EQ.3.) WRITE(6,647)
IF(DECRUL.EQ.4.) WRITE(6,648)
IF(DECRUL.EQ.5.) WRITE(6,649)
WRITE(6,616)
WRITE(6,617)
WRITE(6,616)
WRITE(6,618)

```

```

RETURN
ENL
SUBROUTINE PREFER
COMMON DECRL, ICONMX(14,14), IGFAL(14),
2PLAN(100,14), ERASE, IPLAN, NPLAN, NPLUS, RECORD(100,6), LIST(100,3),
3IGNFIE(14), IGPASS(14), IGYTIE(14), IX, IYESGP(14),
4LEADNO, LEADYS, M, N, NCYCLE, NFAIL, NOGRP(14), NPASS,
5APOW, NTIES, POWCCF(14), POWIG(14), COFIDF(14,14),
6POWNC, POWSUM, POZMAT(14,8), POWYES,
7XNEW, IG(14), IATTR( 8), NLYES(14), NLNO(14), LOOPS, X,
8TVNO(14,8), TVYES(14,8), GOALS(14,8,2),
9SHARE(8), TEST(14,8), CRITNO(14), CRITYS(14),
*IGNG(14), IGYES(14), SPNO, SPYES, SSPNO, SSPYES,
*AVPNC, AVPYES, SDPNO, SCPYES, RELPNO, RELPY, RSDPNO, RSDPYS,
*TLL(14,14), TUL(14,14), IBEST1(14), IBEST2(14), IBEST3(14),
*FCLC, IHOLD, NLESS, IIPLAN, LINE, STANCE, COACT, II,
*NSTALP, IGNSM(14), IGYSM(14)
600 FORMAT('1', 'SUBROUTINE PREFER HAS JUST CALCULATED THE POSITION MA
1TRIX ', ///)
601 FORMAT(1X, '
1
602 FORMAT(1X)
603 FCRMAT('O')
604 FORMAT('1')
605 FORMAT('4')
606 FORMAT(36X, 'POSITION MATRIX',/)
607 FORMAT(1X, 'IG NC.', 2X, 8(12,4X))
608 FCRMAT(3X, I2, 1X, 8F6.2)
609 FCRMAT(///)
610 FORMAT(1X, '
,/)
611 FORMAT(3X, 'PREFERRED PROJECT ATTRIBUTE FOR EACH IG',/)
612 FORMAT(1X, 'IG NC. ', I2, ' LIKES ATTRIBUTE NO. ', I2, ' BEST OF ALL')
613 FORMAT(4X, 'SECOND FAVORITE ATTRIBUTE FOR EACH IG',/)
614 FORMAT(1X, 'IG NC. ', I2, ' LIKES ATTRIBUTE NO. ', I2, ' SECOND BEST')

```

```

615 FORMAT(4X,'THIRD FAVORITE ATTRIBUTE FOR EACH IG',/)
616 FORMAT(1X,'IG NC. ',I2,' LIKES ATTRIBUTE NO. ',I2,' THIRD BEST')
617 FORMAT(1X,'THE COEFFICIENT OF DIFFERENCE BETWEEN EACH PAIR OF IGS
      1 IS',/)
618 FORMAT(14X,14(I2,6X))
619 FORMAT(1X,'IG NC. ',I2,2X,14(F6.2,2X))
      C
      INITIALIZE
      DO 5 I=1,N
      DO 5 J=1,N
      COFCIF(I,J)=0.
      5 CONTINUE
      DO 1 I=1,N
      ILIKE1=IBEST1(I)
      ILIKE2=IBEST2(I)
      ILIKE3=IBEST3(I)
      DO 1 K=1,N
      IF(K.EQ.I) GO TO 1
      CIF1=POZMAT(I,ILIKE1)-POZMAT(K,ILIKE1)
      CIF2=POZMAT(I,ILIKE2)-POZMAT(K,ILIKE2)
      CIF3=POZMAT(I,ILIKE3)-POZMAT(K,ILIKE3)
      ABDIF1=ABS(DIF1)
      ABDIF2=ABS(DIF2)
      ABDIF3=ABS(DIF3)
      COFCIF(I,K)=0.65*ABDIF1+0.25*ABDIF2+C.10*ABDIF3
      1 CONTINUE
      WRITE(6,600)
      WRITE(6,601)
      WRITE(6,602)
      WRITE(6,606)
      WRITE(6,607) (IATTR(J),J=1,M)
      WRITE(6,601)
      WRITE(6,603)
      DO 6 I=1,N
      WRITE(6,608) IG(I), (POZMAT(I,J),J=1,M)

```



```

0  CONTINUE
  WRITE(6,601)
  WRITE(6,609)
  WRITE(6,610)
  WRITE(6,611)
  WRITE(6,610)
  WRITE(6,612)
  WRITE(6,610)
  WRITE(6,604)
  WRITE(6,610)
  WRITE(6,613)
  WRITE(6,610)
  WRITE(6,614)
  WRITE(6,610)
  WRITE(6,609)
  WRITE(6,610)
  WRITE(6,615)
  WRITE(6,610)
  WRITE(6,616)
  WRITE(6,610)
  WRITE(6,604)
  WRITE(6,601)
  WRITE(6,603)
  WRITE(6,617)
  WRITE(6,618)
  CC 10 I=1,N
  WRITE(6,619) IG(I),(COFCIF(I,K),K=1,N)
10 CONTINUE
  WRITE(6,601)
  RETURN
  END
  SUBROUTINE POWER
  COMMON DECRUL,ICONMX(14,14),IGFAIL(14),
2FLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),

```

```

3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNO,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5APOW,NTIES,POWCOF(14),POWIG(14),COFIDIF(14,14),
6PCWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNO(14,8),TVYES(14,8),COALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELNO,RELAYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLD,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
C      DIMENSION SUM(14)
600 FORMAT('1','SUBROUTINE POWER HAS JUST CALCULATED POWER COEFFICIENT
1TS')
601 FORMAT(1X)
602 FORMAT('O')
603 FORMAT('1')
604 FORMAT('+')
605 FORMAT(10X,'TOTAL POWER AVAILABLE IN THE BARGAINING ARENA = POWSUM
1 = ',F10.2)
606 FORMAT(10X,'
1,/)
607 FORMAT(10X,'INTEREST GROUP NUMBER POWER COEFFICIENT RAW POWER
1,/)
608 FORMAT(11X,'*****',12,8X,F8.4,9X,F8.2)
C      INITIALIZE
C      DO 9 I=1,N
C      DO 9 J=1,NPOW
C      WPCWM(I,J)=0.
C      PCWIG(I)=0.
C      POWCCF(I)=0.
9 CONTINUE
C      DO 5 I=1,N

```

```

IF(I.GT.1) GO TO 6
SUMM =POWIG(I)
GO TO 5
6 SUMM =SUMM +POWIG(I)
5 CONTINUE
PCWSUM=SUMM
TO AVOID DIVIDING BY ZERO
IF(PCWSUM.EQ.0.) GO TO 8
C CALCULATION OF POWER COEFFICIENTS. POWCOF=POWIG/POWSUM
GO 7 I=1,N
POWCCF(I)=POWIG(I)/PCWSUM
7 CONTINUE
8 CONTINUE
WRITE(6,600)
WRITE(6,602)
WRITE(6,605) POWSUM
WRITE(6,602)
WRITE(6,606)
WRITE(6,607)
WRITE (6,606)
DO 15 I=1,N
WRITE(6,608) IG(I), POWCOF(I),POWIG(I)
15 CONTINUE
WRITE(6,606)
RETURN
END
SUBROUTINE DECIDE
COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5NPCW,NTIES,PCWCCF(14),PCWIG(14),COFIDF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,

```

```

8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,REL PNO,REL PYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*FCLD,IHOLD,NLESS,IPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14).
600 FORMAT('1','SUBROUTINE DECIDE HAS JUST CALCULATED THE TESTING CRI
      1TERIA ',//)
601 FORMAT(1X)
602 FORMAT('C')
603 FORMAT('1')
604 FORMAT('+')
605 FORMAT(1X,'
1
607 FORMAT(15X,'WTEST FOR WATER ALLOCATIONNO COMPARED TO TVNO AND T
      1VYES ',//)
608 FORMAT(35X,'PROJECT ATTRIBUTES',//)
609 FORMAT(1X,'IG NC.',9X, 8(I2,6X))
611 FORMAT(7X,'TVNO =', 8F8.3)
612 FORMAT(7X,'TVYES=', 8F8.3,/)
613 FORMAT(3X,I2,2X,'WTEST=', 8F8.3)
614 FORMAT(1X,'
      1,//)
615 FORMAT(3X,'PREFERRED PROJECT ATTRIBUTE FOR EACH IG')
616 FORMAT(1X,'IG NC. ',I2,' LIKES ATTRIBUTE NO. ',I2,' BEST OF ALL')
617 FORMAT(1X,' CURRENT PROJECT ALLOCATION FOLLOWS ')
618 FORMAT(1X,'
      1,//)
619 FCRMAT(1X,'PROJECT ATTRIBUTE',6X, 8(I2,6X))
620 FORMAT(1X,'CURRENT ALLOCATION ', 8F8.2,/)
621 FORMAT(1X,'IG NC. ',I2,' LIKES ATTRIBUTE NO. ',I2,' BEST OF ALL, A
      1TATTRIBUTE NO. ',I2,' SECOND BEST, AND ATTRIBUTE NO. ',I2,' THIRD BE
      2ST')
C INITIALIZE

```

```

CO 3 I=1,N
CO 3 J=1,M
TEST(I,J)=0.
3 CONTINUE
C  CALCULATION OF TESTING CRITERIA WHICH DETERMINES OPPOSITION *
C*  CR  CONCURRENCE WITH EACH PLAN COMPONENT
CO 2 I=1,N
CO 2 J=1,M
IF(GCALS(I,J,2).GT.0.) GO TO 7
IF(GCALS(I,J,2).LT.0.) GO TO 8
TO AVOID DIVIDING BY ZERO
7 IF(GCALS(I,J,1).EQ.0.) GO TO 2
TEST(I,J)=SHARE(J)/GOALS(I,J,1)
GO TO 10
8 TEST(I,J)=(1.-SHARE(J))/(1.-GOALS(I,J,1))
10 IF(TEST(I,J).GT.1.) TEST(I,J)=1.01
2 CONTINUE
IF(ERASE.EQ.0.) GO TO 11
IF(NCYCLE.GT. 1 .AND.NCYCLE.LT.LOOPS) GO TO 11
WRITE(6,600)
WRITE(6,605)
WRITE(6,601)
WRITE(6,607)
WRITE(6,608)
WRITE(6,609)
WRITE(6,605)
WRITE(6,602)
CO 5 I=1,N
WRITE(6,613) IG(I),(TEST(I,J),J=1,M)
WRITE(6,611) (TVNO(I,J),J=1,M)
WRITE(6,612) (TVYES(I,J),J=1,M)
5 CONTINUE
WRITE(6,602)
WRITE(6,605)

```

```

WRITE(6,602)
WRITE(6,618)
WRITE(6,615)
WRITE(6,618)
WRITE(6,621) (IG(I),IBEST1(I),IBEST2(I),IBEST3(I),I=1,N)
WRITE(6,618)
WRITE(6,602)
WRITE(6,617)
WRITE(6,602)
WRITE(6,618)
WRITE(6,619) (IATTR(J),J=1,M)
WRITE(6,620) (SHARE(J),J=1,M)
WRITE(6,618)
11 CONTINUE
RETURN
END
SUBROUTINE FOE
COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5APCW,NTIES,POWCCF(14),POWIG(14),COFOIF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SOPNO,SDPYES,RELPMO,RELPMY,RSDPNO,RSDPMY,
*ILL(14,14),TUL(14,14),IDEST1(14),IBEST2(14),IBEST3(14),
*PCLC,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
600 FORMAT('1')
601 FORMAT(1X,'SUBROUTINE FOE HAS JUST CALCULATED CONFLICT MATRICES')
602 FORMAT('0')

```



```

603 FORMAT(1X,'
1
604 FORMAT(12X,'CONFLICT MATRIX FOR BARGAINING CYCLE NO. ',I3,/)
605 FORMAT(10X,'POTENTIAL CONFLICT EXISTS AMONG THE FOLLOWING IG',/)
606 FORMAT(12X,14(I2,2X))
607 FORMAT(1X,'IG NO. ',I2,2X,14(I2,2X))
      DO 5 I=1,N
      DO 5 J=1,N
      ICONPX(I,J)=0
5 CONTINUE
      DO 1 I=1,N
      INDEX=1
      DO 1 K=1,N
      IF(I.EQ.K) GO TO 1
      IF(CCFDIF(I,K).GE.0. .AND. COFDIF(I,K).LT.TLL(I,K))GO TO 1
      IF(CCFDIF(I,K).GE.TLL(I,K).AND.COFDIF(I,K).LT.TUL(I,K))GO TO 3
      IF(CCFDIF(I,K).GE.TUL(I,K).AND.COFDIF(I,K).LE.2.0)GO TO 2
2 ICONPX(I,INDEX)=K
  INDEX=INDEX+1
  GO TO 1
3 CALL NRAN
  IF(X.EQ.0.) GO TO 3
  IF(X.GT.0.) GO TO 2
1 CONTINUE
  IF(ERASE.EQ.0.) GO TO 6
  IF(NCYCLE.GT.1.AND.NCYCLE.LT.LOOPS) GO TO 6
  WRITE(6,600)
  WRITE(6,601)
  WRITE(6,602)
  WRITE(6,603)
  WRITE(6,604) NCYCLE
  WRITE(6,605)
  WRITE(6,606) (IG(I),I=1,N)
  WRITE(6,603)

```

```

60 7 I=1,N
   WRITE(6,607) IG(I), (ICONMX(I,J), J=1,N)
7  CONTINUE
   WRITE(6,603)
6  CONTINUE
   RETURN
END
SUBROUTINE LEADER
COMMON DECRL, ICONMX(14,14), IGFAIL(14),
2PLAN(100,14), ERASE, IPLAN, NPLAN, NPLUS, RECORD(100,6), LIST(100,3),
3IGNTIE(14), IGPASS(14), IGYTIE(14), IX, IYESGP(14),
4LEADNC, LEADYS, M, N, NCYCLE, NFAIL, NOGRP(14), NPASS,
5NPOW, NTIES, POWCGF(14), POWIG(14), COFDIF(14,14),
6POWNC, POWSUM, POZMAT(14,8), POWYES,
7XNEW, IG(14), IATTR( 8), NLYES(14), NLNO(14), LOOPS, X,
8TVAG(14,8), TVYES(14,8), GOALS(14,8,2),
9SHARE(8), TEST(14,8), CRITNO(14), CRITYS(14),
*IGNC(14), IGYES(14), SPNO, SPYES, SSPNO, SSPYES,
*AVPNC, AVPYES, SDPNO, SDPYES, RELPNO, RELPYS, RSDPNO, RSDPYS,
*TLL(14,14), TUL(14,14), IBEST1(14), IBEST2(14), IBEST3(14),
*FOLD, IHOLD, NLESS, IIPLAN, LINE, STANCE, COACT, II,
*NSTALM, IGNSM(14), IGYSM(14)
600 FORMAT('1')
601 FORMAT(1X, 'SUBROUTINE LEADER HAS JUST CALCULATED THE COEFFICIENTS
1 OF DISSATISFACTION')
602 FORMAT('0')
603 FORMAT(1X, '
1
        ',/)
604 FORMAT(31X, 'FOR PLAN NO. ', I3,/)
605 FORMAT(1X, 'THE COEFFICIENTS OF DISSATISFACTION FOR THOSE IGS
2 VOTING NO ARE',/)
606 FORMAT(24X, 'INTEREST GROUP', 5X, 'CRITNO',/)
607 FORMAT(29X, 'IG NO. ', I2, 5X, F5.3)
608 FORMAT(1X, 'SUBROUTINE LEADER HAS JUST CALCULATED THE COEFFICIENTS

```

```

3 OF SATISFACTION')
609 FORMAT(IX,'THE COEFFICIENTS OF SATISFACTION FOR THOSE IGS VOTING
4 YES ARE',/)
610 FORMAT(24X,'INTEREST GROUP',5X,'CRITYS',/)
C*
INITIALIZE
IF(NCYCLE.GT.1) GO TO 8
DO 7 I=1,N
  NLYES(I)=0
  NLNC(I)=0
  IGNC(I)=0
  IGVES(I)=0
7 CONTINUE
8 CONTINUE
LEADNC=0
LEADYS=0
FINC=0.
FIVES=0.
DO 15 I=1,N
  CRITNO(I)=0.
  CRITYS(I)=0.
  NOGRP(I)=0
  IYESGP(I)=0
15 CONTINUE
C
C COMPARE TEST WITH THE THRESHOLD VALUES
DO 1 I=1,N
  ILIKE1=IDEST1(I)
  ILIKE2=IDEST2(I)
  ILIKE3=IDEST3(I)
C ADD INCREMENT TO TVNO TO AVOID ROUNDING ERROR IN CLASSIFICATION
  IF( TEST(I,ILIKE1).LE.(TVNO(I,ILIKE1)+0.01)) GO TO 6
C SUBTRACT INCREMENT FROM TVYES, AVOID ROUNDING ERROR OF CLASSIFICATION
  IF( TEST(I,ILIKE1).GE.(TVYES(I,ILIKE1)-0.01)) GO TO 27
  IF( TEST(I,ILIKE2).LE.(TVNO(I,ILIKE2)+0.01).AND. TEST(I,ILIKE3).LE.
    1(TVNC(I,ILIKE3)+0.01)) GO TO 3

```

```

      IF(TEST(I,ILIKE2).GE.(TVYES(I,ILIKE2)-0.01).AND.TEST(I,ILIKE3).GE.
2(TVYES(I,ILIKE3)-0.01)) GO TO 5
2 CALL NRAN
  IF(X.EQ.0.) GO TO 2
  IF(X.LT.0.) GO TO 3
  IF(X.GT.0.) GO TO 5
6 IF(TEST(I,ILIKE2).GE.(TVYES(I,ILIKE2)-0.01).AND.TEST(I,ILIKE3).GE.
2(TVYES(I,ILIKE3)-0.01)) GO TO 2
  GO TO 3
27 IF(TEST(I,ILIKE2).LE.(TVNO(I,ILIKE2)+0.01).AND.TEST(I,ILIKE3).LE.
1(TVNC(I,ILIKE3)+0.01)) GO TO 2
  GO TO 5
C   ADD IG I TO NO COALITION
3 IGNC(I)=IGNO(I)+1
  ACGRP(I)=1
C   EVALUATE HIS COEFFICIENT OF DISSATISFACTION (1-TEST)
  PSEUD1=1.0 - TEST(I,ILIKE1)
  PSEUD2=1.0 - TEST(I,ILIKE2)
  PSEUD3=1.0 - TEST(I,ILIKE3)
  CRITNO(I)=0.35*PCWCOF(I)+0.35*PSEUD1+0.20*PSEUD2+0.10*PSEUD3
  IF(CRITNC(I).EQ.FINO) GO TO 12
  IF(CRITNC(I).GT.FINO) GO TO 11
  GO TO 1
12 CALL NRAN
  IF(X.EQ.0.) GO TO 12
  IF(X.LT.0.) GO TO 11
  GO TO 1
11 HINC=CRITNO(I)
  LEADNC=I
  GO TO 1
C   ADD IG I TO YES COALITION
5 IGYES(I)=IGYES(I)+1
  IYESGP(I)=1
C   EVALUATE HIS COEFFICIENT OF SATISFACTION (TEST)

```

```

CRITYS(I)=0.35*POWCOF(I)+0.35*TEST(I,ILIKE1)+0.20*TEST(I,ILIKE2)+0
1,10*TEST(I,ILIKE3)
IF(CRITYS(I).EQ.+1YES) GO TO 13
IF(CRITYS(I).GT.+1YES) GO TO 14
GO TO 1
13 CALL NRAN
IF(X.EQ.0.) GO TO 13
IF(X.GT.0.) GO TO 14
GO TO 1
14 +1YES=CRITYS(I)
LEADYS=I
1 CONTINUE
C TO AVOID HAVING A ZERO SUBSCRIPT IN NLNO OR NLYES
IF(LEADNC.EQ.0) GO TO 9
NLNO(LEADNO)=NLNO(LEADNO)+1
9 IF(LEADYS.EQ.0) GO TO 10
NLYES(LEADYS)=NLYES(LEADYS)+1
10 CONTINUE
IF(NCYCLE.GT.1) GO TO 16
WRITE(6,600)
WRITE(6,601)
WRITE(6,602)
WRITE(6,603)
WRITE(6,604) IPLAN
WRITE(6,605)
WRITE(6,606)
CC 17 I=1,N
WRITE(6,607) IG(I), CRITNO(I)
17 CONTINUE
WRITE(6,603)
WRITE(6,602)
WRITE(6,602)
WRITE(6,602)
WRITE(6,608)

```

```

WRITE(6,602)
WRITE(6,603)
WRITE(6,604) IPLAN
WRITE(6,609)
WRITE(6,610)
DO 18 I=1,N
  WRITE(6,607) IG(I), CRITYS(I)
18 CONTINUE
  WRITE(6,603)
16 CONTINUE
  RETURN
END
SUBROUTINE ALIGN
COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5NPOW,NTIES,PCWCCF(14),PCWIG(14),COFDIF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELPNO,RELPHY,RSDPNO,RSDPHY,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*FOLC,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
IF(NCYCLE.GT.1) GO TO 15
  INITIALIZE
  NSTALM=0
  NTIES=0
  NPASS=0
  NFAIL=0
  SPNC=0.

```

C*


```

SPYES=0.
SSPNC=0.
SSPYES=0.
AVPNC=0.
AVPYES=0.
SCPNC=0.
SDPYES=0.
RELPCNC=0.
RELPPYS=0.
RSCPNC=0.
RSDPYS=0.
DO 16 I=1,N
IGYSM(I)=0
IGNSM(I)=0
IGNTIE(I)=0
IGYTIE(I)=0
IGPASS(I)=0
IGFAIL(I)=0
16 CONTINUE
15 CCNTINUE
C INITIALIZE
NUMYES=0
NUMNC=0
POWYES=0.
POWNC=0.
RAWPY=0.
RAWPN=0.
C CHECK EACH IG FOR COALITION FORMATION BEHAVIOR
DO 1 I=1,N
IF(CCACT.EQ.3.) GO TO 40
IF(NCGRP(I).EQ.1) GO TO 3
GO TO 5
3 IF(LEADNC.EQ.0) GO TO 5
IF(CCACT.EQ.2.) GO TO 41

```

```

C      DO 4 K=1,N
C      COACT CONTROLS CERTAIN OUTPUT FROM SUBROUTINE REPORT
C      IF(I.EQ.ICONMX(LEADNO,K)).OR.LEADNO.EQ.ICONMX(I,K)) GO TO 21
C      4 CONTINUE
C      41 DO 42 K=1,N
C      IF(I.EQ.ICONMX(LEADNO,K)) GO TO 23
C      42 CONTINUE
C      GO TC 25
C      23 DO 24 K=1,N
C      IF(LEADNO.EQ.ICONMX(I,K)) GO TO 21
C      24 CONTINUE
C      GO TC 25
C      40 IF(NCGRP(I).EQ.1) GO TO 25
C      GO TC 29
C      25 NUMNC=NUMNO+1
C      POWNC=POWNO+POWCCF(I)
C      RAWPN=RAWPN+POWIG(I)
C      GO TC 1
C      21 NCGRP(I)=0
C      GO TC 1
C      5 IF(LEADYS.EQ.0) GO TO 1
C      IF(CCACT.EQ.2.) GO TO 43
C      DO 6 L=1,N
C      IF(I.EQ.ICONMX(LEADYS,L).OR.LEADYS.EQ.ICONMX(I,L)) GO TO 22
C      6 CONTINUE
C      GO TC 29
C      43 DO 44 L=1,N
C      IF(I.EQ.ICONMX(LEADYS,L)) GO TO 27
C      44 CONTINUE
C      GO TO 29
C      27 DO 28 L=1,N
C      IF(LEADYS.EQ.ICONMX(I,L)) GO TO 22
C      28 CONTINUE
C      GO TC 29

```

```

29 NUMYES=NUMYES+1
PCWYES=PCWYES+PCWCOF(I)
RAWPY=RAWPY+POWIG(I)
GO TC 1

22 IYESGP(I)=0
1 CONTINUE
C CHECK FOR WINNING COALITION
C CHECK DECISION RULES
  IF(DECRUL.EQ.1.) GO TO 50
  IF(DECRUL.EQ.2.) GO TO 51
  IF(DECRUL.EQ.3.) GO TO 52
  IF(DECRUL.EQ.4.) GO TO 53
  IF(DECRUL.EQ.5.) GO TO 54
C DECISION RULES REQUIRE A PLURALITY OF POWER
50 IF(PCWNO.LT.POWYES) GO TO 10
  IF(PCWNO.GT.POWYES) GO TO 12
  IF(PCWNO.EQ.POWYES) GO TO 8
C DECISION RULES REQUIRE A MAJORITY OF POWER
51 DECMAJ=0.5*POWSUM
  IF(RAWPN.GE.DECMAJ) GO TO 12
  IF(RAWPY.GE.DECMAJ) GO TO 10
  GO TC 30

C TWO-THIRDS OF THE POWER REQUIRED FOR A PLAN TO BE PASSED OR DEFEATED
52 DEC23=0.667*POWSUM
  IF(RAWPN.GE.DEC23) GO TO 12
  IF(RAWPY.GE.DEC23) GO TO 10
  GO TC 30

C DECISION RULES REQUIRE A PLURALITY OF VOTES
53 IF(NUMYES.GT.NUMNO) GO TO 10
  IF(NUMNO.GT.NUMYES) GO TO 12
  GO TC 8

C DECISION RULES REQUIRE A MAJORITY OF VOTES
54 NHALF=N/2
  IF(NUMYES.GT.NHALF) GO TO 10

```

```

IF(NUMNO.GT.NHALF) GO TO 12
GO TC 30
C  SUMMARIZE ROUNDS THAT ENDED IN A STALEMATE FOR LACK OF A MAJORITY
30 NSTALM=NSTALM+1
   CC 31 I=1,N
   IGNSM(I)=IGNSM(I)+NOGRP(I)
   IGYSM(I)=IGYSM(I)+IYESGP(I)
31 CONTINUE
   GO TC 14
C  SUMMARIZE TIES
   8 NTIES=NTIES+1
   DO 9 I=1,N
   IGNTIE(I)=IGNTIE(I)+NOGRP(I)
   IGYTIE(I)=IGYTIE(I)+IYESGP(I)
   9 CONTINUE
   GO TC 14
C*  SUMMARIZE WINNING COALITIONS THAT PASS THE PROJECT
   10 NPASS=NPASS+1
   DO 11 K=1,N
   IGPASS(K)=IGPASS(K)+IYESGP(K)
   11 CONTINUE
   GO TC 14
C  SUMMARIZE WINNING COALITIONS THAT DEFEAT THE PROJECT
   12 NFAIL=NFAIL+1
   DO 13 L=1,N
   IGFAIL(L)=IGFAIL(L)+NOGRP(L)
   13 CONTINUE
   14 CONTINUE
CALCULATE MEAN AND STD. DEV. OF YES AND NO POWER
      SPNC=SPNC+RAWPN
      SPYES=SPYES+RAWPY
      SSPNC=SSPNC+RAWPN**2
      SSPYES=SSPYES+RAWPY**2
      IF(ACYCLE.LT.LOCCPS) GO TO 19

```

```

AVPNC=SPNC/LOOPS
AVPYES=SPYES/LOOPS
REL PAC=AVPNO/POWSUM
REL PYS=AVPYES/PCWSUM
IF((SSPNC-(SPNO**2/LOOPS)).LT.0.) GO TO 20
SDPNC=((SSPNO-(SPNO**2/LOOPS))/(LOOPS-1))*(.5)
RSDPAC=SDPNO/POWSUM
20 CONTINUE
IF((SSPYES-(SPYES**2/LOOPS)).LT.0.) GO TO 19
SDPYES=((SSPYES-(SPYES**2/LOOPS))/(LOOPS-1))*(.5)
RSDPYS=SDPYES/PCWSUM
19 CONTINUE
RETURN
END
SUBROUTINE REPORT
COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NGRP(14),NPASS,
5NPOW,NTIES,PCWCCF(14),POWIG(14),COFDIF(14,14),
6FCWNC,PUWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,REL PNO,REL PYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLD,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*INSTALM,IGNSM(14),IGYSM(14)
C ***
C *
C *
C *
C *
C *
SUBROUTINE REPORT GENERATES A SUMMARY OF THE BARGAINING ROUND
AFTER LCOPS NUMBER OF VOTING CYCLES
C *
C *

```

```

600  FORMAT('1','THIS ROUND OF BARGAINING IS COMPLETE. ','//',' SUBROUT
LINE REPORT WILL NOW DISPLAY RESULTS OF THE CURRENT SESSION. CONSID
ERING PLAN NUMBER ',I3)
601  FORMAT(1X)
602  FORMAT('0')
603  FORMAT('1')
604  FORMAT('+' )
605  FORMAT('0','LEADERSHIP SUMMARY')
606  FORMAT('0','11X','IG NO.','5X,14(13,3X))
607  FORMAT(1X,'NO. TIMES IG LEAD','5X,14(13,3X))
608  FORMAT(1X,'THE OPPOSITION ')
609  FORMAT(1X,'NO. TIMES IG LEAD','5X,14(13,3X))
610  FORMAT(1X,'THE CONCURRENCE ','5X,14(13,3X))
611  FORMAT(10X,'THE VOTING WAS TIED ',I3,' BARGAINING ROUNDS')
612  FORMAT(10X,'THE PROJECT RECEIVED A PASSING VOTE ',I3,' BARGAINING
1 CYCLES.')
613  FORMAT(10X,'THE PROJECT WAS DEFEATED ',I3,' BARGAINING CYCLES.')
614  FORMAT(10X,'THERE WERE ',I4,' TOTAL VOTING ROUNDS ON THIS PROJECT
1')
616  FORMAT(1X,'
1
617  FORMAT(13X,'NO. TIMES','5X,'NO. TIMES','7X,'NO. TIMES','8X,'NO. TIMES
1 NO. TIMES NO. TIMES')
618  FORMAT(14X,'HE CAST','7X,'HE CAST','9X,'HE CAST','10X,'HE CAST
1 HE CAST HE CAST')
619  FORMAT(1X,'INTEREST','4X,' NO VOTE','4X,' YES VOTE','4X,' NO VOTE
1 THAT','3X,' YES VOTE THAT NO VOTE YES VOTE')
620  FORMAT(2X,'GROUP','5X,'TIED ROUNDS','3X,'TIED ROUNDS','4X,'HELPED DEF
1EAT','5X,'HELPED PASS')
621  FORMAT(2X,'NUMBER','36X,'PROJECT','10X,'PROJECT',/)
622  FORMAT(4X,12,10X,I3,11X,I3,12X,I3,14X,I3,13X,I3,9X,I3)
624  FORMAT(1X,'BEGIN VOTING SUMMARY FOR UPPER ST. JOHNS RIVER BASIN***
1*****')

```



```

626 FORMAT(1X,'*****END OF VOTING SUMMARY FOR PLAN NUMBER ',I3,
1' GO TO THE NEXT PLAN*****')
627 FORMAT(1X,'
1
628 FORMAT(10X,'THE AVERAGE OPPOSITION CUMULATIVE POWER WAS ',F6.4,
1' WITH A STANDARD DEVIATION= ',F10.8,' OR (',F8.2,' AND ',F8.2,
1)')
629 FORMAT(10X,'THE AVERAGE CONCURRENCE CUMULATIVE POWER WAS ',F6.4,
1' WITH A STANDARD DEVIATION= ',F10.8,' OR (',F8.2,' AND ',F8.2,
1)')
630 FORMAT(1X,'*****BEGIN BARGAINING ON PLAN NUMBER',I3,' *****
1*****')
631 FORMAT(2X,'INTEREST GROUPS',48X,'QUANTIFIED PROJECT ISSUES')
632 FORMAT(11,' 1. CATTLEMEN NO. 1',T60,' 1. WATER SUPPLY FOR MELBOUR
1NE',T1,' 2. CATTLEMEN NO. 2',T60,' 2. WATER FOR IRRIGATION',T1,
3' 3. CITRUS GROWERS, T60,' 3. AGRICULTURAL PRODUCTION',T1,
3 4. RESIDENTIAL DEVELOPERS',T60,' 4. RESIDENTIAL DEVELOPMENT',T1
4,' 5. GAME + FISH COMM.',T60,' 5. WATER QUALITY',T1,' 6. ENVIRO
6NMENTAL PROTECTION AGENCY',T60,' 6. MARSHLAND, FISH + WILDLIFE PRE
7SERVATION',T1,' 7. AUDUBON SOCIETY',T60,' 7. NO. OF RECREATIONAL
8 OPPORTUNITIES',T1,' 8. LEAGUE OF WOMEN VOTERS',T60,' 8. DEGREE
9CF FLOOD PROTECTION' /,T1,' 9. BREVARD COUNTY COMMISSIONERS',T1,
1' 10. FLOOD CONTROL DISTRICT',T1,' 11. CORPS OF ENGINEERS',T1,
212. MELBOURNE CITY COUNCIL PRO' /,T1,' 13. MELBOURNE CITY COUNCIL
3CON' /,T1,' 14. CONCERNED CITIZENS PRO')
634 FORMAT(1X,'
1
635 FORMAT(27X,'SOCIAL INDICATORS',/).
636 FORMAT(15X, 8(I2,3X))
637 FORMAT(1X,'PROJECT')
638 FORMAT(1X,'EFFECTS',6X, 8(F4.2,1X), ' IBEST1',1X,'IBEST2',1X,'IBEST
13',/)
639 FORMAT(1X,'GOALS IG ',I2,2X, 8(F4.2,1X),2X,I2,5X,I2,5X,I2)
640 FORMAT(1X,'***** ALL INTEREST GROUPS SHARE CONCILIATORY MCOOD

```

```

1.  THEY ARE WILLING TO MODIFY THEIR POSITIONS TO A SOFT LINE 'I//
2)
641 FORMAT(1X,'***** THE INTEREST GROUPS ARE NOT VERY CONCILIATO
TRY. THEY HAVE TAKEN A HARD LINE AND ARE UNWILLING TO CHANGE',/)
642 FORMAT(1X,'***** ONE-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS SUFFICIENT FOR IGS TO REFUSE TO JOIN',/)
643 FORMAT(1X,'***** TWO-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS REQUIRED BEFORE IGS REFUSE TO JOIN',/)
644 FORMAT(1X,'***** NO CONFLICT CONSIDERED IN COALITION FORMATI
1CN. THUS NO IG CAN ABSTAIN AND A MAJORITY IS REQUIRED',/)
645 FORMAT(1X,'***** DECISION RULES REQUIRE A PLURALITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',/)
646 FORMAT(1X,'***** DECISION RULES REQUIRE A MAJORITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',/)
647 FORMAT(1X,'***** DECISION RULES REQUIRE TWO-THIRDS OF THE PO
1WER FOR A PLAN TO BE PASSED OR DEFEATED',/)
648 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
1CTE',/1X,'***** ONLY A PLURALITY OF VOTES IS REQUIRED FOR A
2 PLAN TO BE PASSED OR DEFEATED',/)
649 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
1CTE',/1X,'***** A MAJORITY OF VOTES IS NECESSARY FOR A PLAN
2 TO BE PASSED OR DEFEATED',/)
650 FORMAT(1X,'OPTICNS IN EFFECT DURING THIS RUN ARE AS FOLLOWS',/)
661 FORMAT(10X,'THE VOTING WAS STALEMATED ',13,' BARGAINING ROUNDS!')
663 FORMAT(2X,'GROUP',5X,'STALEMATED ',3X,'STALEMATED ',4X,'HELPED DEF
1EAT',5X,'HELPED PASS')
664 FORMAT(2X,'NUMBER',6X,'ROUNDS',9X,'PROJECT',10X,'PROJE
1CT',/)
WRITE(6,603)
CC 4 I=1,5
WRITE(6,630) IPLAN
4 CONTINUE
WRITE(6,602)
WRITE(6,631)

```

```

WRITE(6,632)
WRITE(6,602)
WRITE(6,634)
WRITE(6,635)
WRITE(6,636) (IATTR(J),J=1,M)
WRITE(6,634)
WRITE(6,637)
WRITE(6,638) (SHARE(J),J=1,M)
DO 5 I=1,N
WRITE(6,639) IG(I), (GOALS(I,J,1),J=1,M),IBEST1(I),IBEST2(I),IBEST
13(I)
5 CONTINUE
WRITE(6,634)
WRITE(6,650)
IF(STANCE.EQ.0.) WRITE(6,640)
IF(STANCE.EQ.1.) WRITE(6,641)
IF(CCACT.EQ.1.) WRITE(6,642)
IF(CCACT.EQ.2.) WRITE(6,643)
IF(CCACT.EQ.3.) WRITE(6,644)
IF(DECRUL.EQ.1.) WRITE(6,645)
IF(DECRUL.EQ.2.) WRITE(6,646)
IF(DECRUL.EQ.3.) WRITE(6,647)
IF(DECRUL.EQ.4.) WRITE(6,648)
IF(DECRUL.EQ.5.) WRITE(6,649)
WRITE(6,600) IPLAN
WRITE(6,624)
WRITE(6,605)
WRITE(6,627)
WRITE(6,606) (IG(I),I=1,N)
WRITE(6,627)
WRITE(6,609) (NLNO(I),I=1,N)
WRITE(6,608)
WRITE(6,602)
WRITE(6,607) (NLYES(I),I=1,N)

```

```

WRITE(6,610)
WRITE(6,627)
WRITE(6,602)
IF(DECRUL.EQ.1. .OR. DECRUL.EQ.4.) WRITE(6,611) NTIES
IF(DECRUL.EQ.2. .OR. DECRUL.EQ.3. .OR. DECRUL.EQ.5.) WRITE(6,661)
1) NSTALM
WRITE(6,612) NPASS
WRITE(6,613) NFAIL
WRITE(6,614) LOOPS
WRITE(6,628) RELPNO,RSDPNO,AVPNO,SDPNO
WRITE(6,629) RELPYS,RSDPYS,AVPYES,SDPYES
WRITE(6,602)
WRITE(6,616)
WRITE(6,617)
WRITE(6,618)
WRITE(6,619)
IF(DECRUL.EQ.1. .OR. DECRUL.EQ.4.) GO TO 10
GO TO 11
10 WRITE(6,620)
WRITE(6,621)
WRITE(6,616)
CO 1 I=1,N
WRITE(6,622) IG(I),IGNTIE(I),IGYTIE(I),IGFAIL(I),IGPASS(I) ,
1 IGNO(I),IGYES(I)
1 CONTINUE
GO TO 12
11 WRITE(6,663)
WRITE(6,664)
WRITE(6,616)
DO 9 I=1,N
WRITE(6,622) IG(I),IGNSM(I),IGYSM(I),IGFAIL(I),IGPASS(I),IGNO(I),I
IGYES(I)
9 CONTINUE
12 WRITE(6,601)

```

```

WRITE(6,616)
DO 3 I=1,5
  WRITE(6,626) IPLAN
3 CONTINUE
  RETURN
END
  SUBROUTINE SAVE
    COMMON DECRL,ICCNMX(14,14),IGFAIL(14),
    2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
    3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
    4LEADNO,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
    5NPWN,NTIES,PCWCCF(14),PGWIG(14),COFDIF(14,14),
    6POWNC,POWSUM,POZMAT(14,8),POWYES,
    7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
    8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
    9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
    *IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
    *AVPNC,AVPYES,SDPNC,SCPYES,RELPNO,RELAYS,RSDPNO,RSDPYS,
    *TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
    *HCLD,IHOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
    *ASTALM,IGNSM(14),IGYSM(14)
    LIST(LINE,2)=NPASS
    LIST(LINE,3)=NFAIL
    RECCRD(LINE,1)=RELAYS
    RECCRD(LINE,2)=RSDPYS
    RECCRD(LINE,3)=RELPNO
    RECCRD(LINE,4)=RSDPNO
    RETURN
  END
  SUBROUTINE SWITCH
    COMMON DECRL,ICCNMX(14,14),IGFAIL(14),
    2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
    3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
    4LEADNO,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,

```

```

5NPOW,NTIES,POWCCF(14),POWIG(14),COFDIF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNC(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELNO,RELAYS,RSDPNO,RSDPYS,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLC,IHOLD,NLESS,IPLAN,LINE,STANCE,COACT,II,
*ASTALM,IGNSM(14),IGYSM(14)
  CO 1 II=1,4
  HOLD=0.
  HOLC=RECCRD(LINE,II)
  RECCRD(LINE,II)=0.
  RECCRD(LINE,II)=RECCRD(LINE+1,II)
  RECCRD(LINE+1,II)=HOLD
1 CONTINUE
  CO 2 II=1,3
  IHOLD=0
  IHOLC=LIST(LINE,II)
  LIST(LINE,II)=0
  LIST(LINE,II)=LIST(LINE+1,II)
  LIST(LINE+1,II)=IHOLD
2 CONTINUE
  RETURN
  END
SUBROUTINE OUTPUT
  COMMON DECRL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5NPOW,NTIES,POWCOF(14),POWIG(14),COFDIF(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,
7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,

```



```

8TVNO(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNO(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELPNO,RELAYS,RSDPNO,RSDPYS,
*ILL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*HOLD,1HOLD,NLESS,IIPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
602 FORMAT('Q')
603 FORMAT(1X,'
1      ',//)
604 FORMAT(1X,'
1 STD.DEV.',/,7X,'PLAN',PERCENT POSSIBLE POWER STD.DEV. PERCENT
1 POWER',/,1X,'RANK NUMB SUCCESS YES YES FAILURE
1NO NO',//)
605 FORMAT(12X,12,3X,13,5X,13,4X,F5.3,3X,F5.3,5X,F5.3,3X,F5.3)
640 FORMAT(1X,'***** ALL INTEREST GROUPS SHARE CONCILIATORY MOOD
1. THEY ARE WILLING TO MODIFY THEIR POSITIONS TO A SOFT LINE '//
2)
641 FORMAT(1X,'***** THE INTEREST GROUPS ARE NOT VERY CONCILIATO
1RY. THEY HAVE TAKEN A HARD LINE AND ARE UNWILLING TO CHANGE',//)
642 FORMAT(1X,'***** ONE-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS SUFFICIENT FOR IGS TO REFUSE TO JOIN',//)
643 FORMAT(1X,'***** TWO-WAY CONFLICT BETWEEN COALITION LEADER
1 AND POTENTIAL MEMBERS IS REQUIRED BEFORE IGS REFUSE TO JOIN',//)
644 FORMAT(1X,'***** NO CONFLICT CONSIDERED IN COALITION FORMATI
1CN. THUS NO IG CAN ABSTAIN AND A MAJORITY IS REQUIRED',//)
645 FORMAT(1X,'***** DECISION RULES REQUIRE A PLURALITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',//)
646 FORMAT(1X,'***** DECISION RULES REQUIRE A MAJORITY OF POWER
1 FOR A PLAN TO BE PASSED OR DEFEATED',//)
647 FORMAT(1X,'***** DECISION RULES REQUIRE TWO-THIRDS OF THE PO
1WER FOR A PLAN TO BE PASSED OR DEFEATED',//)
648 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
1CTE',/,1X,'***** ONLY A PLURALITY OF VOTES IS REQUIRED FOR A

```

```

2 PLAN TO BE PASSED OR DEFEATED',/)
640 FORMAT(1X,'***** DECISION RULES ARE ONE-INTEREST-GROUP-ONE-V
ICTE',/1X,'***** A MAJORITY OF VOTES IS NECESSARY FOR A PLAN
2 TO BE PASSED OR DEFEATED',/)
650 FORMAT(1X,'OPTIONS IN EFFECT DURING THIS RUN ARE AS FOLLOWS',/)
WRITE(6,602)
WRITE(6,650)
IF(STANCE.EQ.0.) WRITE(6,640)
IF(STANCE.EQ.1.) WRITE(6,641)
IF(CCACT.EQ.1.) WRITE(6,642)
IF(CCACT.EQ.2.) WRITE(6,643)
IF(CCACT.EQ.3.) WRITE(6,644)
IF(DECRUL.EQ.1.) WRITE(6,645)
IF(DECRUL.EQ.2.) WRITE(6,646)
IF(DECRUL.EQ.3.) WRITE(6,647)
IF(DECRUL.EQ.4.) WRITE(6,648)
IF(DECRUL.EQ.5.) WRITE(6,649)
WRITE(6,603)
WRITE(6,604)
WRITE(6,603)
DO 1 I=1,NPLAN
WRITE(6,605) I,(LIST(I,J),J=1,2),(RECORD(I,J),J=1,2),
1 LIST(I,3),(RECORD(I,J),J=3,4)
1 CONTINUE
WRITE(6,603)
RETURN
END
SUBROUTINE NRAN
COMMON DECRUL,ICONMX(14,14),IGFAIL(14),
2PLAN(100,14),ERASE,IPLAN,NPLAN,NPLUS,RECORD(100,6),LIST(100,3),
3IGNTIE(14),IGPASS(14),IGYTIE(14),IX,IYESGP(14),
4LEADNC,LEADYS,M,N,NCYCLE,NFAIL,NOGRP(14),NPASS,
5NPOW,NTIES,POWCCF(14),POWIG(14),COFDIR(14,14),
6POWNC,POWSUM,POZMAT(14,8),POWYES,

```

```

7XNEW,IG(14),IATTR( 8),NLYES(14),NLNO(14),LOOPS,X,
8TVNG(14,8),TVYES(14,8),GOALS(14,8,2),
9SHARE(8),TEST(14,8),CRITNO(14),CRITYS(14),
*IGNC(14),IGYES(14),SPNO,SPYES,SSPNO,SSPYES,
*AVPNC,AVPYES,SDPNO,SDPYES,RELPNO,RELPHY,RSOPNO,RSDPHY,
*TLL(14,14),TUL(14,14),IBEST1(14),IBEST2(14),IBEST3(14),
*PCLC,IHOLD,NLESS,IPLAN,LINE,STANCE,COACT,II,
*NSTALM,IGNSM(14),IGYSM(14)
C*****
C*
C* THE SUBROUTINE NRAN GENERATES A N(0,1) DISTRIBUTED RANDOM *
C* NUMBER. ONLY ONE INITIAL SEED IS REQUIRED. THEREAFTER A SEED *
C* IS AUTOMATICALLY GENERATED FOR THE REMAINDER OF THE PROGRAM *
C*****
C*****
C DIMENSION R(24)
C GENERATE 24 UNIFCRMLY DISTRIBUTED RANDOM NUMBERS N(0,1)
DO 1 I=1,24
  IY=IX*65539
  IF(IY)2,3,3
  2 IY=IY+2147483647+1
  3 YFL=IY
  IX=IY
  1 R(I)=YFL*.4656613E-9
C ACC TOGETHER THE 24 UNIFORMLY DISTRIBUTED RANDOM NUMBERS
SUM=0.0
DO 4 I=1,24
  4 SUM=SUM+R(I)
CC BY THE C.L.T.H.M., THE SUM IS NORMALLY DISTRIBUTED
C1 NCRMALIZE THIS SUM, X REPRESENTS THE APPROPRIATE RAN. NO.
X=(SUM/1.41421)-8.48526
RETURN
END

```

LIST OF REFERENCES

- Abelson, Robert P. "Mathematical Models in Social Psychology," in *Advances in Experimental Social Psychology*, Vol. 3, Leonard Berkowitz, ed., Academic Press, New York, 1967, pp. 1-54.
- Abelson, Robert P., and Alex Bernstein. "A Computer Simultaion Model of Community Referendum Controversies," *Public Opinion*, Spring 1963, pp. 93-122.
- Abt Associates, Inc. *Factors Affecting Pollution Referenda*, Contract #14-12-902, Environmental Protection Agency, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., June 1971, 331 pp.
- Agger, Robert E., Daniel Goldrich, and Bert E. Swanson. *The Rulers and the Ruled*, John Wiley & Sons, Inc., New York, 1964, 293 pp.
- Alker, Hayward R., Jr. "Computer Simulations, Conceptual Frameworks, and Coalition Behavior," in *The Study of Coalition Behavior*, Sven Groennings, E. W. Kelley, and Michael Leiserson, eds., New York, 1970, pp. 369-395.
- Altshuler, Alan. "The Goals of Comprehensive Planning," *Journal of the American Institute of Planners*, August 1965, pp. 186-194.
- Andrews, Wade H., and Dennis C. Geertszen. *The Function of Social Behavior in Water Resource Development*, Research Report No. 1, Center for Water Resources Research, Utah State University, Logan, Utah, December 1970, 135 pp.
- Archibald, K. S. "Three Views of the Expert's Role in Policymaking: Systems Analysis, Incrementalism, and the Clinical Approach," *Policy Science*, Spring 1970, pp. 73-86.
- Argyris, Chris. *Understanding Organizational Behavior*, Richard D. Irwin, Inc., Homewood, Illinois, 1960, 179 pp.
- Argyris, Chris. "Some Limits of Rational Man Organizational Theory," *Public Administration Review*, May/June 1973, pp. 253-267.
- Arnstein, Sherry R. "A Ladder of Citizen Participation," *Journal of the American Institute of Planners*, July 1969, pp. 216-224.

- Arrow, Kenneth J. "Utilities, Attitudes, Choices: A Review Note," *Econometrica*, January 1958, pp. 1-23.
- Arrow, Kenneth J. *Social Choice and Individual Values*, 2nd ed., Cowles Foundation Monograph 12, Yale University Press, New Haven, Conn., 1963, 124 pp.
- Arrow, Kenneth J. "Mathematical Models in the Social Sciences," in *Reading in the Philosophy of the Social Sciences*, May Brodbeck, ed., The Macmillan Company, Toronto, 1968, pp. 635-667.
- ASCE. *Research Needs in Civil Engineering Relevant to the Goals of Society*, Colorado State University and the American Society of Civil Engineers, New York, June 1971, 318 pp.
- Ayres, Robert U., and Allen V. Kneese. "Production, Consumption, and Externalities," *American Economic Review*, June 1969, pp. 282-297.
- Baier, Kurt, and Nicholas Rescher, eds. *Values and the Future*, The Free Press, New York, 1969, 527 pp.
- Banfield, Edward C. "Ends and Means in Planning," *International Social Science Journal*, No. 3, 1959, pp. 361-367.
- Banfield, Edward C. *Political Influence*, The Free Press, New York, 1964, 353 pp.
- Bartos, Otomar. *Simple Models of Group Behavior*, Columbia University Press, New York, 1967, 345 pp.
- Bauer, Raymond A., ed. *Social Indicators*, The M.I.T. Press, Cambridge, Massachusetts, 1966, 357 pp.
- Bauer, Raymond A., and Kenneth J. Gergen, eds. *The Study of Policy Formation*, The Free Press, New York, 1968, 392 pp.
- Baur, E. Jackson. *Assessing the Social Effects of Public Works Projects*, Research Paper No. 3, Resident Scholar Program, U.S. Army Corps of Engineers, Fort Belvoir, Virginia, July 1973, 35 pp.
- Becker, Gordon M., and Charles G. McClintock. "Value: Behavioral Decision Theory," *Annual Review of Psychology*, 1967, pp. 239-286.
- Bell, Roderick, David V. Edwards, and R. Harrison Wagner. *Political Power*, The Free Press, New York, 1969, 400 pp.
- Bernholz, Peter. "Logrolling, Arrow Paradox and Cyclical Majorities," *Public Choice*, Summer 1973, pp. 87-95.
- Beum, Corlin O., Jr., and Everett G. Brundage. "A Method for Analyzing Sociomatrix," *Sociometry*, May 1950, pp. 141-145.

- Bishop, A. Bruce. *Public Participation in Water Resources Planning*, IWR Report 70-7, Institute for Water Resources, Alexandria, Virginia, December 1970, 109 pp.
- Bishop, A. Bruce, C. H. Oglesby, and Gene E. Willeke. *Socio-Economic and Community Factors in Planning Urban Freeways*, Report EEP-33, Program in Engineering-Economic Planning, Stanford University, Stanford, California, October 1969, 215 pp.
- Bishop, Robert L. "Game-Theoretic Analysis of Bargaining," *Quarterly Journal of Economics*, November 1963, pp. 559-602.
- Black, Duncan. *The Theory of Committees and Elections*, Cambridge University Press, New York, 1958, 242 pp.
- Blau, Peter M. *Exchange and Power in Social Life*, John Wiley & Sons, Inc., New York, 1964a, 352 pp.
- Blau, Peter M. "Differentiation of Power," in *Exchange and Power in Social Life*, John Wiley & Sons, Inc., New York, 1964b.
- Blau, Peter M. "Theories of Organizations," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 11, pp. 297-305.
- Blau, Peter M., and Scott W. Richard. *Formal Organizations*, Chandler Publishing Company, San Francisco, 1962, 312 pp.
- Bolan, Richard S. "Emerging Views of Planning," *Journal of the American Institute of Planners*, July 1967, pp. 233-245.
- Bolan, Richard S. "Community Decision Behavior: The Culture of Planning," *Journal of the American Institute of Planners*, September 1969, pp. 301-310.
- Bolle, Arnold W. "Public Participation and Environmental Quality," *Natural Resources Journal*, July 1971, pp. 497-505.
- Borgatta, Edgar F. "Sociometry," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 15, pp. 53-57.
- Borton, Thomas E., Katherine P. Warner, J. William Wenrich, Spenser W. Havlick, and John Frost. *The Susquehanna Communication-Participation Study*, IWR Report 70-6, Institute for Water Resources, Alexandria, Virginia, December 1970, 128 pp.
- Boulding, Kenneth E. "General Systems Theory: The Skeleton of Science," *Management Science*, April 1956, pp. 197-208.

- Boulding, Kenneth E. *Conflict and Defense*, Harper & Row, Publishers, New York, 1962, 349 pp.
- Boulding, Kenneth E. "The Ethics of Rational Decision," *Management Science*, February 1966, pp. B161-B169.
- Boulding, Kenneth E. "Dare We Take the Social Sciences Seriously?" *American Psychologist*, October 1967, pp. 879-887.
- Boulding, Kenneth E. *Beyond Economics*, The University of Michigan Press, Ann Arbor, 1968, 302 pp.
- Bowden, Leonard W. *Diffusion of the Decision to Irrigate*, Research Paper No. 97, Department of Geography, University of Chicago, Chicago, 1965, 146 pp.
- Braybrooke, David, and Charles E. Lindblom. *A Strategy of Decision*, The Free Press, New York, 1963, 268 pp.
- Bromley, Daniel W., A. Allan Schmid, and William B. Lord. *Public Water Resource Project Planning and Evaluation: Impacts, Incidence, and Institutions*, Working Paper #1, Center for Resource Policy Studies and Programs, School of Natural Resources, University of Wisconsin, Madison, September 1971, 39 pp.
- Brown, B., S. Lochran, and N. Dalkey. *The Delphi Method, II: Structure of Experiments*, RM-5957, The Rand Corporation, Santa Monica, Calif., June 1969, 131 pp.
- Brown, R. M., N. I. McClelland, R. A. Deininger, and M. F. O'Connor. "A Water Quality Index--Crashing the Psychological Barrier," Paper No. A/15/29, *Proceedings 6th International Conference on Water Pollution Research*, Jerusalem, Israel, 18-23 June 1972, 8 pp.
- Buchanan, James M. "An Individualistic Theory of Political Process," in *Varieties of Political Theory*, David Easton, ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966, pp. 25-37.
- Buchanan, James M. "Toward Analysis of Closed Behavioral Systems," in *Theory of Public Choice*, James M. Buchanan and Robert D. Tollison, eds., The University of Michigan Press, Ann Arbor, 1972, pp. 11-23.
- Buchanan, James M., and Gordon Tullock. *The Calculus of Consent*, The University of Michigan Press, Ann Arbor, 1962, 361 pp.
- Buckley, Walter. *Sociology and Modern Systems Theory*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1967, 227 pp.
- Buckley, Walter, ed. *Modern Systems Research for the Behavioral Scientist*, Aldine Publishing Company, Chicago, 1968, 525 pp.

- Bulkley, J. W. "Modelling Decision Effectiveness--Application to Water Resource Systems," in *Proceedings International Symposium on Modelling Techniques in Water Resource Systems*, Ottawa, Canada, 9-12 May 1972, pp. 274-288.
- Bulkley, Jonathan W., and Julie Antill. "Validation of Political Simulation Models--Water Resource Projects," *Water Resources Bulletin*, October 1971, pp. 1071-1080.
- Bulkley, J. W., and R. T. McLaughlin. *Simulation of Political Interaction in Multiple-Purpose River-Basin Development*, Report No. 100, Hydrodynamics Laboratory, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, October 1966, 307 pp.
- Bunker, Douglas R. "Policy Science Perspectives on Implementation Processes," *Policy Sciences*, March 1972, pp. 71-80.
- Burke, Roy III, James P. Heaney, and Edwin E. Pyatt. "Political Interactions and Water Resources Management: A Quantitative Approach," in *Watersheds in Transition*, Sandor C. Csallany, Thad G. McLaughlin, and William D. Striffler, eds., Proceedings Series No. 14, American Water Resources Association, Urbana, Illinois, 1972a, pp. 39-39.
- Burke, Roy III, James P. Heaney, and Edwin E. Pyatt. "Environmental Plan Formulation and Implementation: An Integrated Approach," *International Symposium on Systems Engineering and Analysis*, Vol. II, Purdue University, Lafayette, Indiana, October 1972b, pp. 56-62.
- Burke, Roy III, James P. Heaney, and Edwin E. Pyatt. "Water Resources and Social Choices," *Water Resources Bulletin*, June 1973c, pp. 433-447.
- Caldwell, Lynton Keith. *Environment: A Challenge to Modern Society*, Anchor Books, Doubleday & Company, Inc., Garden City, New York, 1971, 301 pp.
- Cartwright, Dorwin, ed. *Studies in Social Power*, The University of Michigan Press, Ann Arbor, 1959a, 225 pp.
- Cartwright, Dorwin, ed. "A Field Theoretical Conception of Power," in *Studies in Social Power*, The University of Michigan Press, Ann Arbor, 1959b, pp. 183-220.
- Cartwright, Dorwin. "Influence, Leadership, Control," in *Handbook of Organizations*, James G. March, ed., Rand McNally and Company, Chicago, 1965.

- Carzo, Rocco, Jr., and John N. Yanouzas. *Formal Organization: A Systems Approach*, Richard D. Irwin, Inc., and The Dorsey Press, Homewood, Illinois, 1967, 591 pp.
- Chabot, James. "A Simplified Example of the Use of Matric Multiplication for the Analysis of Sociometric Data," *Sociometry*, May 1950, pp. 131-140.
- Chadwick, George. *A Systems View of Planning*, Pergamon Press, New York, 1971, 390 pp.
- Chasan, Daniel Jack. "The Seattle Area Wouldn't Allow Death of Its Lake," *Smithsonian*, July 1971, pp. 6-13.
- Chertkoff, Jerome M. "Sociopsychological Theories and Research on Coalition Formation," in *The Study of Coalition Behavior*, Sven Groennings, E. W. Kelley, and Michael Leiserson, eds., Holt, Rinehart and Winston, Inc., New York, 1970, pp. 297-322.
- Churchman, C. West. *The Systems Approach*, Dell Publishing Company, Inc., New York, 1968, 243 pp.
- Ciriacy-Wantrup, S. V. "The Economics of Environmental Policy," *Land Economics*, February 1971, pp. 36-45.
- Clark, Terry M., ed. *Community Structure and Decision Making: Comparative Analysis*, Chandler Publishing Company, San Francisco, California, 1968, 498 pp.
- Clyde, Edward W., and Dallin W. Jensen. *Administrative Allocation of Water*, Report No. NWC-L-71-025, National Water Commission, Arlington, Virginia, July 1971, 126 pp.
- Cochrane, James L., and Milan Zeleny, eds. *Multiple Criteria Decision Making*, University of South Carolina Press, Columbia, 1973, 816 pp.
- Coleman, James S. "The Mathematical Study of Small Groups," in *Mathematical Thinking in the Measurement of Behavior*, Herbert Solomon, ed., The Free Press of Glencoe, Illinois, 1960, pp. 1-149.
- Coleman, James S. "Collective Decisions," *Sociological Inquiry*, September 1964a, pp. 166-181.
- Coleman, James S. *Introduction to Mathematical Sociology*, The Free Press, New York, 1964b, 554 pp.
- Coleman, James S. "Mathematical Models and Computer Simulation," in *Handbook of Modern Sociology*, Robert E. L. Faris, ed., Rand McNally & Company, Chicago, 1964c, pp. 1027-1062.

- Coleman, James S. *Models of Change and Response Uncertainty*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1964d, 130 pp.
- Coleman, James S. "Foundations for a Theory of Collective Decisions," *American Journal of Sociology*, May 1966a, pp. 615-627
- Coleman, James S. "Individual Interests and Collective Action," in *Papers on Non-Market Decision Making*, Gordon Tulloch, ed., Thomas Jefferson Center for Political Economy, University of Virginia, Charlottesville, 1966b, pp. 49-62.
- Coleman, James S. "The Possibility of a Social Welfare Function," *American Economic Review*, December 1966c, pp. 1105-1122.
- Coleman, James S. *Control of Collectivities and the Power of a Collectivity to Act*, P-3902, The Rand Corporation, Santa Monica, California, August 1968, 39 pp.
- Coleman, James S. *The Mathematics of Collective Action*, Aldine Publishing Company, Chicago, 1973, 191 pp.
- Collins, Barry E., and Harold Guetzkow. *A Social Psychology of Group Processes for Decision-Making*, John Wiley & Sons, Inc., New York, 1964, 254 pp.
- Consulting Panel on Water Resource Planning. *Water Resource Planning*, Report No. NWC-EES-72-057, National Water Commission, Arlington, Virginia, June 1972, 238 pp.
- Coomber, Nicholas H., and Asit K. Biswas. *Evaluation of Intangibles*, Genera Press, Bronxville, New York, 1973, 77 pp.
- Coombs, Clyde H. "Psychological Scaling Without a Unit of Measurement," *Psychological Review*, March 1950, pp. 145-158.
- Coombs, Clyde H. *A Theory of Data*, John Wiley & Sons, Inc., New York, 1964, 585 pp.
- Coombs, Clyde H., Robyn M. Dawes, and Amos Tversky. *Mathematical Psychology*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970, 419 pp.
- Cooper, William W., II, H. J. Leavitt, and M. W. Shelly II. *New Perspectives in Organizational Research*, John Wiley and Sons, Inc., 1964, 606 pp.
- Coplin, William D., ed. *Simulation in the Study of Politics*, Markham Publishing Company, Chicago, 1968, 365 pp.

- Cornblit, Oscar. "Political Coalitions and Political Behaviour: A Simulation Model," in *Experimentation and Simulation in Political Science*, J. A. Laponce and Paul Smoker, eds., University of Toronto Press, Toronto, 1972, pp. 225-258.
- Coser, Lewis A. *The Functions of Social Conflict*, The Free Press, New York, 1956, 188 pp.
- Coser, Lewis A. "Conflict: Social Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 3, pp. 232-236.
- Council on Environmental Quality. "Statements on Proposed Federal Actions Affecting the Environment: Guidelines," *Federal Register*, Vol. 36, No. 19, Part II, Washington, D. C., 28 January 1971, pp. 1398-1402 (1971a).
- Council on Environmental Quality. "Statements on Proposed Federal Actions Affecting the Environment: Guidelines," *Federal Register*, Vol. 36, No. 79, Part II, Washington, D.C., 23 April 1971, pp. 7724-7729 (1971b).
- Cross, John G. "A Theory of the Bargaining Process," *American Economic Review*, March 1965, pp. 67-94.
- Cross, John G. "Some Theoretic Characteristics of Economic and Political Coalitions," *Journal of Conflict Resolution*, June 1967, pp. 184-195.
- Cross, John G. *The Economics of Bargaining*, Basic Books, Inc., New York, 1969, 247 pp.
- Crowe, Beryl L. "The Tragedy of the Commons Revisited," *Science*, November 1969, pp. 1103-1107.
- Curry, Robert L., and Larry L. Wade. *A Theory of Political Exchange*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968, 130 pp.
- Cyert, Richard M., and James G. Maret. *A Behavioral Theory of the Firm*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963.
- Dahl, Robert A. *A Preface to Democratic Theory*, The University of Chicago Press, Chicago, 1956, 154 pp.
- Dahl, Robert A. "The Concept of Power," *Behavioral Science*, July 1957, pp. 201-215.
- Dahl, Robert A. *Who Governs?* Yale University Press, New Haven, Connecticut, 1961, 355 pp.

- Dahl, Robert A. "Power," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 12, pp. 405-415.
- Dahl, Robert A. *After the Revolution?* Yale University Press, New Haven, Connecticut, 1970, 171 pp.
- Dakin, John. "An Evaluation of the 'Choice' Theory of Planning," *Journal of the American Institute of Planners*, February 1963, pp. 19-28.
- Dalkey, Norman C. *The Delphi Method: An experimental Study of Group Opinion*, RM-5888-PR, The Rand Corporation, Santa Monica, Calif., June 1969, 79 pp.
- Dalkey, B. Brown, and S. Cochran. *The Delphi Method, III: Use of Self Ratings to Improve Group Estimates*, RM-6115-PR, The Rand Corporation, Santa Monica, Calif., November 1969, 21 pp.
- Dalkey, N., B. Brown, and S. Cochran. *The Delphi Method, IV: Effect of Percentile Feedback and Feed-In of Relevant Facts*, RM-6118-PR, The Rand Corporation, Santa Monica, Calif., March 1970, 39 pp.
- Dalkey, Norman C., and Daniel L. Rourke. *Experimental Assessment of Delphi Procedures With Group Value Judgements*, R-612-ARDA, The Rand Corporation, Santa Monica, Calif., February 1971, 49 pp.
- Dallmayr, Fred R. "Empirical Political Theory & the Images of Man," *Polity*, Summer 1970, pp. 443-478.
- Davidoff, Paul. "Advocacy and Pluralism in Planning," *Journal of the American Institute of Planners*, November 1965, pp. 331-338.
- Davidoff, Paul, and Thomas A. Reiner. "A Choice Theory of Planning," *Journal of the American Institute of Planners*, May 1962, pp. 103-115.
- Davidson, Paul. "The Valuation of Public Goods," in *Social Sciences and the Environment*, Morris E. Garasey and James R. Hibbs, eds., University of Colorado Press, Boulder, Colorado, 1967, pp. 125-154.
- Davis, Richard M., Darryl L. Hessel, and Gary S. Stacey. *Urban Public Policy and Political Institutions for Water Quality Management on Lake Erie: Year One*, Battelle Columbus Laboratories, Columbus, Ohio, April 1972, 65 pp.
- Davis, Otto A., and Melvin Hinich. "A Mathematical Model of Policy Formation in a Democratic Society," in *Mathematical Applications in Political Science*, Vol. II, Joseph L. Bernd, ed., Southern Methodist University Press, Dallas, 1966, pp. 175-208.

- Davis, Otto A., and Melvin Hinich. "Some Results Related to a Mathematical Model of Policy Formation in a Democratic Society," in *Mathematical Applications in Political Science*, Vol. III, Joseph L. Bernd, ed., The University of Virginia Press, Charlottesville, 1967, pp. 14-38.
- Davis, Otto A., and Melvin J. Hinich. "On the Power and Importance of the Mean Preference in a Mathematical Model of Democratic Choice," *Public Choice*, Fall 1968, pp. 59-72.
- Davis, Otto A., Melvin J. Hinich, and Peter C. Ordeshook, "An Expository Development of a Mathematical Model of the Electoral Process," *American Political Science Review*, June 1970, pp. 426-448.
- Davis, Otto A., and Andrew B. Whinston. "On the Distinction Between Public and Private Goods," *American Economic Review*, May 1967, pp. 360-373.
- Dee, Norbert, Janet K. Baker, Neil L. Drobny, Kenneth M. Duke, and David C. Fahringer. *Environmental Evaluation System for Water Resource Planning*, Battelle Columbus Laboratories, Columbus, Ohio, January 1972, 188 pp.
- Delogu, Orlando E. *Legal and Governmental Structures for Water Management in Metropolitan Areas*, Report No. NWC-L-71-016, National Water Commission, Arlington, Virginia, July 1971, 86 pp.
- Deutsch, Karl W. *The Nerves of Government*, The Free Press, New York, 1966, 316 pp.
- Deutsch, Morton. "Toward an Understanding of Conflict," *International Journal of Group Tensions*, January-March 1971, pp. 42-54.
- Dodge, Burnham H. "Achieving Public Involvement in the Corps of Engineers' Water Resources Planning," *Water Resources Bulletin*, June 1973, pp. 448-454.
- Doerksen, Harvey R. *Columbia River Interstate Compact, Politics of Negotiation*, Report No. 11, Water Research Center, Washington State University, Pullman, Washington, August 1972, 196 pp.
- Dorfman, R., and H. D. Jacoby. "A Model of Public Decisions Illustrated by a Water Pollution Policy Problem," in *The Analysis and Evaluation of Public Expenditures: The PPB System*, U.S. Congress, Joint Economic Committee, 91st Congress, 1st Session, 1969, pp. 226-274.
- Dorfman, Robert, and Henry D. Jacoby. "A Model of Public Decisions Illustrated by a Water Pollution Policy Problem," in *Public Expenditures and Policy Analysis*, Robert H. Haveman and Julius Margolis, eds., Markham Publishing Company, Chicago, 1971, pp. 173-231.

- Downs, Anthony. *An Economic Theory of Democracy*, Harper & Row, Publishers, Inc., New York, 1957, 310 pp.
- Downs, Anthony. "The Public Interest: Its Meaning in a Democracy," *Social Research*, Spring 1962, pp. 1-36.
- Downs, Anthony. "A Theory of Bureaucracy," *American Economic Review*, May 1965, pp. 439-446.
- Downs, Anthony. *Bureaucratic Structure and Decisionmaking*, RM-4646-1-PR, The Rand Corporation, Santa Monica, Calif., October 1966, 171 pp.
- Dror, Yehezkel, "Policy Analysis: A New Professional Role in Government Service," *Public Administration Review*, September 1967, pp. 197-203.
- Dror, Yehezkel, *Public Policymaking Reexamined*, Chandler Publishing Company, Scranton, Pennsylvania, 1968, 370 pp.
- Dror, Yehezkel. "Prolegomena to Policy Sciences," *Policy Sciences*, Spring 1970, pp. 135-150.
- Dror, Yehezkel. *Ventures in Policy Sciences*, American Elsevier Publishing Company, Inc., New York, 1971, 321 pp.
- Dyckman, John W. "Planning and Decision Theory," *Journal of the American Institute of Planners*, November 1961, pp. 335-345.
- Dyckman, John W. "The Practical Uses of Planning Theory," *Journal of the American Institute of Planners*, September 1969, pp. 298-300.
- Dyckman, John. "New Normative Styles in Urban Studies," *Public Administration Review*, May/June 1971, pp. 327-334.
- Dynes, Russell R., and Dennis Wenger. "Factors in the Community Perception of Water Resource Problems," *Water Resources Bulletin*, August 1971a, pp. 644-651.
- Dynes, Russell R., and Dennis E. Wenger. *A Model of Community Problem Solving and Selected Empirical Applications*, Water Resources Center, Ohio State University, Columbus, December 1971b, 153 pp.
- Easton, David. *A Framework for Political Analysis*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1965, 143 pp.
- Easton, David. *The Political System*, 2nd ed., Alfred A. Knopf, New York, 1971, 377 pp.
- Economic Research Service. *A History of Federal Water Resources Programs, 1800-1960*, Miscellaneous Publication No. 1233, U.S. Department of Agriculture, Washington, D.C., June 1972, 51 pp.

- Edmondson, W. Thomas. "Lake Washington," in *Environmental Quality and Water Development*, Charles R. Goldman, ed., Report No. NWC-EES-72-032, National Water Commission, Arlington, Virginia, 1971, Section XV, pp. 1-31.
- Edwards, Ward. "The Theory of Decision Making," *Psychological Bulletin*, July 1954, pp. 380-417.
- Edwards, Ward. "Behavioral Decision Theory," *Annual Review of Psychology*, 1961, pp. 473-498.
- Edwards, Ward, and Amos Tversky. *Decision Making*, Penguin Books, Inc., Baltimore, 1967, 413 pp.
- Eisenstadt, Samuel. "Social Institutions: The Concept," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 14, pp. 409-421.
- Ellis, Brian. *Basic Concepts of Measurement*, Cambridge University Press, New York, 1968, 220 pp.
- Environmetrics, Inc. *The River Basin Model*, Environmental Protection Agency, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., December 1971.
- Etzioni, Amitai. *Complex Organizations*, Holt, Rinehart and Winston, Inc., New York, 1961, 497 pp.
- Etzioni, Amitai. *Modern Organizations*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1964, 120 pp.
- Etzioni, Amitai. "Mixed-Scanning: A 'Third' Approach to Decision Making," *Public Administration Review*, December 1967, pp. 385-392.
- Etzioni, Amitai. *The Active Society*, The Free Press, New York, 1968, 698 pp.
- Ewing, David W. *The Human Side of Planning*, The Macmillan Company, Toronto, 1969, 216 pp.
- Fallidi, Andreas. "The 'Systems View' and Planning Theory," *Socio-Economic Planning Sciences*, February 1973, pp. 67-77.
- Farquharson, Robin. *Theory of Voting*, Yale University Press, 1969, 83 pp.
- Festinger, Leon. "The Analysis of Sociograms Using Matrix Algebra," *Human Relations*, 1949, pp. 153-158.

- Fink, Clinton F. "Some Conceptual Difficulties in the Theory of Social Conflict," *Journal of Conflict Resolution*, December 1968, pp. 412-460.
- Fishburn, Peter C. *Decision and Value Theory*, Publications in Operations Research No. 10, John Wiley & Sons, Inc., New York, 1964, 451 pp.
- Fishburn, Peter C. "Methods of Estimating Additive Utilities," *Management Science*, March 1967, pp. 435-453.
- Fisher, Sethard. "Community-Power Studies: A Critique," *Social Research*, Winter 1962, pp. 449-466.
- Fisher, Suzy. "The Cross-Florida Barge Canal: A Lesson in Ecology," *Civil Engineering*, April 1971, pp. 44-48.
- Flack, J. Ernest. "Allocation of Resources," in *Treatise on Urban Water Systems*, Maurice L. Albertson, L. Scott Tucker, and Donald C. Taylor, eds., Colorado State University, Fort Collins, July 1971, pp. 319-325.
- Flack, J. Ernest. "New Techniques for Participative Planning in Water Resources," Paper 7.6, International Symposium on Uncertainties in Hydrologic and Water Resource Systems, University of Arizona, Tucson, December 1972.
- Flack, J. Ernest, and Duane W. Hill. "Effective Water Resources Management in the Urban Setting," *Water Resources Bulletin*, July-August 1970, pp. 563-572.
- Flack, J. Ernest and David A. Summers. "Computer-Aided Conflict Resolution in Water Resource Planning: An Illustration," *Water Resources Research*, December 1971, pp. 1410-1414.
- Flament, Claude. *Applications of Graph Theory to Group Structure*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963, 142 pp.
- Flanders, Allan, ed. *Collective Bargaining*, Penguin Books, Inc., Baltimore, 1969, 431 pp.
- Flanigan, William, and Edwin Fogelman. "Functional Analysis," in *Contemporary Political Analysis*, James C. Charlesworth, ed., The Free Press, New York, 1967, pp. 72-86.
- Flathman, Richard E. *The Public Interest*, John Wiley & Sons, Inc., New York, 1966, 197 pp.
- Florida Department of Natural Resources. *St. Johns River Basin*, Tallahassee, Florida, 1970.

- Forrester, Jay W. *Industrial Dynamics*, The M.I.T. Press, Massachusetts Institute of Technology, Cambridge, 1961, 464 pp.
- Forsyth, Elaine, and Leo Katz. "A Matrix Approach to the Analysis of Sociometric Data," *Sociometry*, 1946, pp. 340-347.
- Fouraker, Lawrence E., and Sidney Siegel. *Bargaining Behavior*, McGraw-Hill Book Company, Inc., New York, 1963, 309 pp.
- Fox, Irving K. "Review and Interpretation of Experiences in Water Resources Planning," in *Organization and Methodology for River Basin Planning*, L. E. Kindsvoter, ed., Water Resources Center, Georgia Institute of Technology, Atlanta, Georgia, 1965, pp. 61-88.
- Fox, Irving K. "Policy Problems in the Field of Water Resources," in *Water Research*, Allen V. Kneese and Stephen C. Smith, eds., The Johns Hopkins Press, Baltimore, 1966, pp. 271-289.
- Fox, Irving K. "Strategic Considerations in Attaining Water Resources Planning Goals," *Journal of the Water Pollution Control Federation*, July 1969, pp. 1368-1376.
- Fox, Irving K. "Institutional Design for Water Quality Management: The Implications of a Systems Approach for Legal and Administrative Arrangements," in *Natural Resource Models in Decision Making*, Gerrit H. Toebe, ed., Water Resources Research Center, Purdue University, Lafayette, Indiana, May 1970, pp. 209-221.
- Fox, Irving K. "Political and Institutional Aspects of the Evaluation of Water Resource Programs," in *Evaluation Processes in Water Resources Planning*, William Whipple, Jr., Ernest A. Engelbert, and Warren L. Trock, eds., Proceedings Series No. 10, American Water Resources Association, Urbana, Illinois, May 1971a, pp. 90-100.
- Fox, Irving K. "Some Political Aspects of the Relationship Between Large Scale Inter-Basin Water Transfers," in *Environmental Quality and Water Development*, Charles R. Goldman, ed., Report No. NWC-EES-72-032, National Water Commission, Arlington, Virginia, 1971b, pp. xxiii 1 - xxiii 28.
- Fox, Irving K. *Water Resources Policy in Wisconsin: Volume 1, A Summary Assessment*, Report No. NWC-71-014, National Water Commission, Arlington, Virginia, 1971c, 164 pp.
- Fox, Irving K. "Some Political Aspects of the Relationship Between Large-Scale Interbasin Water Transfers and Environmental Quality," in *Environmental Quality and Water Development*, Charles R. Goldman, James McEvoy III, and Peter J. Richerson eds., W. H. Freeman and Company, San Francisco, 1973, pp. 413-424.

- Freeman, A. Myrick III. "Advocacy and Resource Allocation Decisions in the Public Sector," *Natural Resources Journal*, April 1969, pp. 166-175.
- French, John R. P., Jr. "A Formal Theory of Social Power," *Psychological Review*, May 1956, pp. 181-194.
- French, John R. P., Jr., and Bertram Raven. "The Bases of Social Power," in *Studies in Social Power*, Dorwin Cartwright, ed., The University of Michigan Press, Ann Arbor, 1959, pp. 150-167.
- Friedmann, John. "A Conceptual Model for the Analysis of Planning Behavior," *Administrative Science Quarterly*, September 1967, pp. 225-252.
- Friedmann, John. "Notes on Societal Action," *Journal of the American Institute of Planners*, September 1969, pp. 311-318.
- Friedmann, John. "The Future of Comprehensive Planning: A Critique," *Public Administration Review*, May/June 1971, pp. 315-326.
- Friedmann, John. "The Public Interest and Community Participation: Toward a Reconstruction of Public Philosophy," *Journal of the American Institute of Planners*, January 1973, pp. 2-12.
- Friedmann, Peter. "Community Decision-Making in the United States: A Review of Recent Research," *The New Atlantis*, Winter 1970, pp. 133-142.
- Friedrich, Carl F. *The Public Interest*, Nomas V, Atherton Press, New York, 1962, 256 pp.
- Frohlich, Norman, Joe A. Oppenheimer, and Oran R. Young. *Political Leadership and Collective Goods*, Princeton University Press, Princeton, New Jersey, 1971, 161 pp.
- Froman, Lewis A., Jr. *People and Politics: An Analysis of the American Political System*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962, 114 pp.
- Froman, Lewis A., Jr. "Public Policy," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 13, pp. 204-208.
- Fromm, Erich. "Thoughts on Bureaucracy," *Management Science*, August 1970, pp. B699-B705.
- Fromm, Erich. "Humanistic Planning," *Journal of the American Institute of Planners*, March 1972, pp. 67-71.

- Gamson, William A. "Experimental Studies of Coalition Formation," in *Advances in Experimental Social Psychology*, Vol. 1, Leonard Berkowitz, ed., Academic Press, New York, 1964, pp. 81-110.
- Gamson, William A. "Coalition Formation," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968a, Vol. 2, pp. 529-534.
- Gamson, William A. "Stable Unrepresentation in American Society," *American Behavioral Scientist*, November-December 1968b, pp. 15-21.
- Gans, Herbert J. "The New Egalitarianism," *Saturday Review*, 6 May 1972, pp. 43-46.
- Gans, Herbert J. "Commentary on 'The Public Interest and Community Participation,'" *Journal of the American Institute of Planners*, January 1973, pp. 3, 10-12.
- Gates, W. E., R. M. Males, and J. F. Walker. "Application of Industrial Dynamics Concepts to Decision Making in Environmental Management," *Water Resources Research*, December 1970, pp. 1549-1558.
- Gemmel, Robert S. et al. *Evaluation of Impacts Arising from the Alternatives for Managing Waste Water in the Chicago-South End Lake Michigan Area*, Chicago District, Corps of Engineers, Chicago, Illinois, August 1972.
- Gergen, Kenneth J. "Assessing the Leverage Points in the Process of Policy Formation," in *The Study of Policy Formation*, Raymond A. Bauer and Kenneth J. Gergen, eds., The Free Press, New York, 1968, pp. 181-203.
- Gilbert, Claire W. *Community Power Structure*, Social Sciences Monograph No. 45, University of Florida Press, Gainesville, Florida, 1972, 73 pp.
- Glanzer, Murray, and Robert Glaser. "Techniques for the Study of Group Structure and Behavior: I. Analysis of Structure," *Psychological Bulletin*, September 1959, pp. 317-332.
- Glanzer, Murray, and Robert Glaser. "Techniques for the Study of Group Structure and Behavior: II. Empirical Studies of the Effects of Structure in Small Groups," *Psychological Bulletin*, January 1961, pp. 1-27.
- Goldman, Charles R., ed. *Environmental Quality and Water Development*, Report No. NWC-EES-72-032, National Water Commission, Arlington, Virginia, 1971.

- Groennings, Sven, E. W. Kelley, and Michael Leiserson. *The Study of Coalition Behavior*, Holt, Rinehart and Winston, Inc., New York, 1970, 489 pp.
- Gross, Bertram M. "The State of the Nation: Social Systems Accounting," in *Social Indicators*, Raymond A. Bauer, ed., The M.I.T. Press, Cambridge, Massachusetts, 1966, pp. 154-271.
- Gross, Bertram M. "The Coming General Systems Models of Social Systems," *Human Relations*, November 1967, pp. 357-374 (also in *Policy Makers and Model Builders*, Vincent P. Rock, ed., Gordon and Breach, Science Publishers, Inc., New York, 1969, pp. 481-522).
- Hadley, G. *Introduction to Probability and Statistical Decision Theory*, Holden-Day, Inc., San Francisco, 1967, 580 pp.
- Haefele, Edwin T. "Coalitions, Minority Representation, and Vote-Trading Probabilities," *Public Choice*, Spring 1970a, pp. 75-90.
- Haefele, Edwin T. "Social Choices and Environmental Quality," *Annual Report*, Resources for the Future, Inc., Washington, D. C., December 1970b, pp. 23-31.
- Haefele, Edwin T. "Social Choices and Individual Preferences: Is There a Connecting Mechanism?" Presented to the Seminar on Economics and Decision Making for Environmental Quality, Department of Agricultural Economics, University of Florida, Gainesville, Florida, 23 February 1971a, 34 pp.
- Haefele, Edwin T. "A Utility Theory of Representative Government," *American Economic Review*, June 1971b, pp. 350-367.
- Haefele, Edwin T. "Social Choice in Residuals Management: Politicizing an Economic Model," Presented at 1971 American Political Science Association Convention, Chicago, September 7, 1971c.
- Haefele, Edwin T. "Environmental Quality or a Problem of Social Choice," in *Environmental Quality Analysis*, Allen V. Kneese and Blair T. Bower, The Johns Hopkins Press, Baltimore, 1972, pp. 281-332.
- Haire, Mason, ed. *Modern Organization Theory*, John Wiley & Sons, Inc., 1959, 324 pp.
- Haith, Douglas A., and Daniel P. Loucks. *The Political Evaluation of Alternative Metropolitan Water-Resource Plans*, Technical Report No. 31, Water Resources and Marine Sciences Center, Cornell University, Ithaca, New York, July 1971, 188 pp.
- Harary, Frank. "Graph Theoretic Methods in the Management Sciences," *Management Science*, July 1959, pp. 387-403.

- Harary, Frank, Robert Z. Norman, and Dorwin Cartwright. *Structural Models: An Introduction to the Theory of Directed Graphs*, John Wiley & Sons, Inc., New York, 1965, 415 pp.
- Hardin, Garrett. "The Tragedy of the Commons," *Science*, December 1968, pp. 1243-2158.
- Harmon, Michael Mont. "Administrative Policy Formulation and the Public Interest," *Public Administration Review*, September/October 1969, pp. 483-491.
- Hartley, William, and Ellen Hartley. "One Woman's Fight to Save a River," *Coronet*, June 1971, pp. 60-65.
- Haveman, Robert H., and Julius Margolis, eds. *Public Expenditures and Policy Analysis*, Markham Publishing Company, Chicago, 1970, 596 pp.
- Hawley, Willis D., and Frederick M. Wirt, eds. *The Search for Community Power*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968, 379 pp.
- Head, J. G. "Public Goods and Public Policy," *Public Finance*, No. 3, 1962, pp. 197-219.
- Heaney, James P., Hasan Sheikh, and Roy Burke III. "Cost Sharing and Optimal Size Sewerage District," Submitted to *Water Resources Research*, December 1972.
- Heaney, James P., Wayne C. Huber, Roy Burke III, Philip B. Bedient, and John J. McLaughlin. *Socio-Economic Studies of the Upper St. Johns River Basin, Central and Southern Florida Flood Control District*, Department of Environmental Engineering Sciences, University of Florida, Gainesville, Florida, November 1973.
- Henderson, James M., and Richard E. Quandt. *Microeconomic Theory*, McGraw-Hill Book Company, New York, 1958, 291 pp.
- Hill, Duane W. "Public Responses: Management's Apparent Enigma," in *Treatise on Urban Water Systems*, Maurice L. Albertson, L. Scott Tucker, and Donald C. Taylor, eds., Colorado State University, Fort Collins, July 1971, pp. 167-172.
- Hodge, Gerald. "Use and Mis-Use of Measurement Scales in City Planning," *Journal of the American Institute of Planners*, May 1963, pp. 112-121.
- Hoinville, G. "Evaluating Community Preferences," *Environment and Planning*, Vol. 3, 1971, pp. 33-50.
- Holden, Matthew, Jr. *Pollution Control as a Bargaining Problem*, Publication No. 9, Water Resources Center, Cornell University, Ithaca, New York, October 1966, 53 pp.

- Holt, Robert T. "A Proposed Structural-Functional Framework," in *Contemporary Political Analysis*, James C. Charlesworth, ed., The Free Press, New York, 1967, pp. 86-107.
- Homans, George C. "Social Behavior as Exchange," *American Journal of Sociology*, May 1958, pp. 597-606.
- Homans, George C. *Social Behavior: Its Elementary Forms*, Harcourt, Brace, and World, New York, 1961, 404 pp.
- Homans, George C. "Groups: The Study of Groups," in *International Encyclopedia of The Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 6, pp. 259-265.
- Horowitz, Irving Louis. "Consensus, Conflict, and Cooperation: A Sociological Inventory," *Social Forces*, December 1962, pp. 177-188.
- Howards, Irving, and Edward R. Kaynor. *Institutional Patterns in Evolving Regional Programs for Water Resources Management*, Publication No. 15, Water Resources Research Center, University of Massachusetts, Amherst, 1971, 238 pp.
- Hufschmidt, Maynard M. "Field Level Planning of Water Resource Systems," *Water Resources Research*, Second Quarter 1965, pp. 147-163.
- Hufschmidt, Maynard M., John Krutilla, and Julius Margolis. *Standards and Criteria for Formulating and Evaluating Federal Water Resources Development*, Report of Panel of Consultants to the Bureau of the Budget, Washington, D.C., 30 June 1961, 71 pp.
- Hunter, Floyd. *Community -Power Structure*, University of North Carolina Press, Chapel Hill, 1953, 297 pp.
- Ingram, Helen M. *Patterns of Politics in Water Resource Development: A Case Study of New Mexico's Role in the Colorado River Basin Bill*, Publication No. 79, The Division of Government Research, The Institute for Social Research and Development, The University of New Mexico, Albuquerque, July 1970, 96 pp.
- Ingram, Helen. "Patterns of Politics in Water Resources Development," *Natural Resources Journal*, January 1971a, pp. 102-118.
- Ingram, Helen. *The New England River Basin Commission*, Report No. NWC-SBS-71-019, National Water Commission, Arlington, Virginia, November 1971b, 59 pp.
- Ingram, Helen. "The Changing Decision Rules in the Politics of Water Development," *Water Resources Bulletin*, December 1972, pp. 1177-1188.

- Institute for Water Resources. *Environmental Guidelines for the Civil Works Program of the Corps of Engineers*, IWR Report 70-5, Alexandria, Virginia, November 1970, 12 pp.
- Isard, Walter, Tony E. Smith, Peter Isard, Tze Hsiung Tuag, and Michael Dacy. *General Theory: Social, Political, Economic, and Regional*, Regional Science Studies Series No. 8, The M.I.T. Press, Cambridge, Massachusetts, 1969, 1040 pp.
- James, L. Douglas, and Robert R. Lee. *Economics of Water Resource Planning*, McGraw-Hill Book Company, New York, 1971, 615 pp.
- Jantsch, Erich, ed. *Perspectives of Planning*, Organisation for Economic Co-operation and Development, Washington, D.C., 1968, 527 pp.
- Jantsch, Erich. "Inter- and Transdisciplinary University: A Systems Approach to Education and Innovation," *Policy Sciences*, December 1970, pp. 403-428.
- Johnsen, Erik. *Studies in Multiobjective Decision Models*, Monograph No. 1, Economic Research Center in Lund, Studentlitteratur, Lund, Sweden, 1968, 628 pp.
- Kahan, James P., and Richard A. Helwig. "'Coalitions': A System of Programs for Computer-Controlled Bargaining Games," *General Systems*, 1971, pp. 31-41.
- Kane, Julius, William Thompson, and Ilan Vertinsky. "Environmental Simulation and Policy Formulation--Methodology and Example (Water Policy for British Columbia)," in *Proceedings of the International Symposium of Modelling Techniques in Water Resources Systems*, Asit K. Kiswas, ed., V1. I, Environment Canada, Ottawa, May 1972, pp. 39-55.
- Kane, Julius, Ilan Vertinsky, and William Thomson. "KSIM: A Methodology for Interactive Resource Policy Simulation," *Water Resources Research*, February 1973, pp. 65-80.
- Karlsson, Georg. "Some Aspects of Power in Small Groups," in *Mathematical Methods in Small Group Processes*, Joan H. Criswell, Herbert Soloman, and Patrick Suppes, ed., Stanford Mathematical Studies in the Social Sciences, VIII, Stanford University Press, Stanford, Calif., 1962, pp. 193-202.
- Kasperson, Roger E. "Political Behavior and the Decision-Making Process in the Allocation of Water Resources Between Recreational and Municipal Use," *Natural Resources Journal*, April 1969, pp. 176-211.

- Kates, Robert W. *Hazard and Choice Perception in Flood Plain Management*, Research Paper No. 78, Department of Geography, University of Chicago, Chicago, 1962, 157 pp.
- Katona, George. "Rational Behavior and Economic Behavior," *Psychological Review*, July 1953, pp. 307-318.
- Katz, Leo. "On the Matric Analysis of Sociometric Data," *Sociometry*, August 1947, pp. 233-241.
- Keene, John C., and Ann Louise Strong. "The Brandywine Plan," *Journal of the American Institute of Planners*, January 1970, pp. 50-58.
- Keil, Charles. *Urban Blues*, The University of Chicago Press, Chicago, 1966, 231 pp.
- Kelley, E. W. "Techniques of Studying Coalition Formation," *Midwest Journal of Political Science*, February 1968, pp. 62-84.
- Kelley, E. W. "Bargaining in Coalition Situations," in *The Study of Coalition Behavior*, Sven Groennings, E. W. Kelley, and Michael Leiserson, eds., Holt, Rinehart and Winston, Inc., New York, 1970a, pp. 273-296.
- Kelley, E. W. "Theory and the Study of Coalition Behavior," in *The Study of Coalition Behavior*, Sven Groennings, E. W. Kelley, and Michael Leiserson, eds., Holt, Rinehart and Winston, Inc., 1970c, pp. 481-489.
- Kendall, Willmoore, and George W. Carey. "The 'Intensity' Problem and Democratic Theory," *American Political Science Review*, March 1968, pp. 5-24.
- Klahr, David. "Decision Making in A Complex Environment: The Use of Similarity Judgements to Predict Preferences," *Management Science*, July 1969, pp. 595-618.
- Klonglan, Gerald E., Paul Yarbrough, and Gene M. Lutz. *Diffusion of Fallout Shelter Innovations*, Monograph Series No. 81, Department of Sociology and Anthropology, Iowa State University, Ames, 1970, 119 pp.
- Kneese, Allen V., and Blair T. Bower. *Managing Water Quality: Economics, Technology, Institutions*, The Johns Hopkins Press, Baltimore, 1968, 328 pp.
- Kneese, Allen V., and Ralph C. d'Arge. "Pervasive External Costs and the Response of Society," in *The Analysis and Evaluation of Public Expenditures*, U.S. Congress, Joint Economic Committee, 91 Congress, 1st Session, 1969, Vol. I, pp. 87-115.

- Knight, John E., and William W. Hines. *Complex System Analysis of Water Quality Dynamics: The Feedback Systems Structure*, Environmental Resources Center, Georgia Institute of Technology, Atlanta, September 1970, 88 pp.
- Knop, Ed. "Social Institutions: A Conceptual, Contextual, and Case Analysis," *Institutions for Urban-Metropolitan Water Management: Essays in Social Theory*, Norman Wengert, ed., Completion Report Series No. 39, Environmental Resources Center, Colorado State University, Fort Collins, Colorado, November 1972, pp. 7-19.
- Koch, Howard E., Jr., Robert C. North, and Dina A. Zinnes. "Some Theoretical Notes on Geography and International Conflict," *Journal of Conflict Resolution*, March 1960, pp. 4-14.
- Kreps, Gary A., and Dennis E. Wenger. "Toward a Theory of Community Conflict: Factors Influencing the Initiation and Scope of Conflict," *Sociological Quarterly*, Spring 1973, pp. 158-174.
- Labovitz, Sanford. "Application of Matrix Algebra to Social Units," *Sociology and Social Research*, January 1967, pp. 220-234.
- Lasswell, Harold D. "Policy Sciences," *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 12, pp. 181-189.
- Lasswell, Harold D. "The Emerging Conception of the Policy Sciences," *Policy Sciences*, Spring 1970, pp. 3-14.
- Laszlo, Ervin. *Introduction to Systems Philosophy*, Harper & Row, Publishers, New York, 1972a, 328 pp.
- Laszlo, Ervin, ed. *The Relevance of General Systems Theory*, George Braziller, New York, 1972b, 213 pp.
- Laszlo, Ervin. *The Systems View of the World*, George Braziller, Inc., New York, 1972c, 131 pp.
- Lawrence, Paul R., and Jay W. Lorsch. *Organization and Environment*, Richard D. Irwin, Inc., Homewood, Illinois, 1969, 279 pp.
- Leiserson, Michael Avery. *Coalitions in Politics: A Theoretical and Empirical Study*, Ph.D. Dissertation, Yale University, New Haven, Connecticut, 1966, 455 pp.
- Leiserson, Michael. "Power and Ideology in Coalition Behavior: An Experimental Study," in *The Study of Coalition Behavior*, Sven Groennings, E. W. Kelley, and Michael Leiserson, eds., Holt, Rinehart and Winston, Inc., New York, 1970b, pp. 323-335.
- Leoni, Bruno. "The Meaning of 'Political' in Political Decisions," *Political Studies*, October 1957, pp. 225-230.

- Levin, P. H. "On Decisions and Decision Making," *Public Administration*, Spring 1972, pp. 19-44.
- LeVine, Robert A. "Anthropology and the Study of Conflict: An Introduction," *Journal of Conflict Resolution*, March 1961, pp. 3-15.
- Lichfield, Nathaniel. "Evaluation Methodology of Urban and Regional Plans: A Review," *Regional Studies*, August 1970, pp. 151-165.
- Lindblom, Charles E. "The Hidden Hand in Government," RM-1434-RC, The Rand Corporation, Santa Monica, Calif., February 1955, 44 pp.
- Lindblom, Charles E. "The Science of 'Muddling Through,'" *Public Administration Review*, Spring 1959, pp. 79-88.
- Lindblom, Charles E. *The Intelligence of Democracy*, The Free Press, New York, 1965.
- Lindblom, Charles E. *The Policy-Making Process*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968, 122 pp.
- Linville, William K. "The Changes in System Modeling Required by Societal System Analysis," *International Symposium on Systems Engineering and Analysis*, Vol. 1, Purdue University, Lafayette, Indiana, October 1972, pp. 75-84.
- Lipsitz, Lewis. "The Study of Consensus," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, 1968, Vol. 3, pp. 266-271.
- Litton, R. Burton, Jr., Robert J. Tetlow, Jens Sorensen, and Russell A. Beatty. *An Aesthetic Overview of the Role of Water in the Landscape*, Report No. NWC-EES-72-035, National Water Commission, Arlington, Virginia, July 1971, 332 pp.
- Looft, William R. "The Psychology of More," *American Psychologist*, June 1971, pp. 561-564.
- Loucks, Daniel P., Charles S. Revelle, and Walter R. Lynn. "Linear Programming Models for Water Pollution Control," *Management Science*, December 1967, pp. B166-B181.
- Lucas, William F. "Measuring Power in Weighted Voting Systems," Mimeodraft, Cornell University, Ithaca, New York, October 1973.
- Luce, R. Duncan, and Albert D. Perry. "A Method of Matrix Analysis of Group Structure," *Psychometrika*, March 1949, pp. 95-118.
- Luce, R. Duncan, and Howard Raiffa. *Games and Decisions*, John Wiley & Sons, Inc., New York, 1957, 509 pp.

- Lugo, Ariel E., and Samuel C. Snedaker, eds., "The Ecosystem Approach to Management," in *Readings on Ecological Systems*, MSS Educational Publishing Co., Inc., New York, 1971, pp. 339-353.
- Lukes, Steven. "Methodological Individualism Reconsidered," *British Journal of Sociology*, June 1968, pp. 119-129.
- Lyden, Fremont J., and Ernest G. Miuer, eds. *Planning Programming Budgeting: A Systems Approach to Management*, Markham Publishing Company, Chicago, 1968, 443 pp.
- Maass, Arthur, Maynard M. Hufschmidt, Robert Dorfman, Harold A. Thomas, Jr., Stephen A. Marglin, and Gordon Maskew Fair. *Design of Water Resource Systems*, Harvard University Press, Cambridge, Massachusetts, 1962, 620 pp.
- MacCrimmon, K. R. *Decisionmaking Among Multiple Attribute Alternatives: A Survey and Consolidated Approach*, RM-4823-ARPA, The Rand Corporation, Santa Monica, Calif., December 1968, 63 pp.
- MacCrimmon, Kenneth R. *Improving the System Design and Evaluation Process by the Use of Trade-Off Information: An Application to Northeast Corridor Transportation Planning*, RM-5877-DOT, The Rand Corporation, Santa Monica, Calif., April 1969, 31 pp.
- MacCrimmon, Kenneth R. "An Overview of Multiple Objective Decision Making," in *Multiple Criteria Decision Making*, James L. Cochrane and Milan Zeleny, eds., University of South Carolina Press, Columbia, 1972, pp. 18-44.
- Mack, Raymond W., and Richard C. Snyder. "The Analysis of Social Conflict," *Journal of Conflict Resolution*, June 1957, pp. 212-248.
- Mackenzie, W. J. M. "Models of Collective Decision-Making," in *The Social Sciences*, UNESCO, Mutan & Co., The Hague, Netherlands, 1968, pp. 356-370.
- Major, David C. "Benefit Cost Ratios for Projects in Multiple Objective Investment Programs," *Water Resources Research*, December 1969, pp. 1174-1178.
- Major, David C., and Associates. "Multiple Objective Redesign of the Big Walnut Project," Water Resources Council--M.I.T. Cooperative Agreement WRC-69-3, 1 April 1970, 52 pp.
- Males, Richard M., and William E. Gates. *Decision Processes in Water Quality Management*, Office of Water Resources Research, U.S. Department of the Interior, Washington, D.C., February 1971.
- Males, Richard M., William E. Gates, and Junius F. Walker. *A Dynamic Model of Water Quality Management Decision Making*, Office of Water Resources Research, U.S. Department of the Interior, Washington, D.C., May 1970.

- Malone, David W. "Modelling Air Pollution Control as a Large Scale, Complex System," *Socio-Economic Planning Sciences*, February 1972, pp. 69-85 (1972a).
- Malone, David W. "System Implementation and Evaluation," *International Symposium on Systems Engineering and Analysis*, Vol. 1, Purdue University, Lafayette, Indiana, October 1972, pp. 133-146 (1972b).
- Manheim, Marvin L. "Reaching Decisions About Technological Projects with Social Consequences: A Normative Model," in *Analytic Formulation of Engineering Problems: Case Studies in Systems Analysis*, Vol. III, R72-57, Richard de Neufville and David H. Marks, eds., Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, September 1972.
- Mann, Lawrence D. "Studies in Community Decision-Making," *Journal of the American Institute of Planners*, February 1964, pp. 58-65.
- March, James G. "An Introduction to the Theory and Measurement of Influence," *American Political Science Review*, June 1955, pp. 431-451.
- March, James G. "Measurement Concepts in the Theory of Influence," *Journal of Politics*, May 1957, pp. 202-226.
- March, James G. *Handbook of Organizations*, Rand McNally & Company, Chicago, 1965, 1247 pp.
- March, James G. "The Power of Power," in *Varieties of Political Theories*, David Easton, ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966, pp. 39-70.
- March, James G., and Herbert A. Simon. *Organizations*, John Wiley and Sons, Inc., New York, 1958, 262 pp.
- Martino, Joseph P. *Technological Forecasting for Decisionmaking*, American Elsevier Publishing Company, Inc., New York, 1972, 750 pp.
- Maslow, A. H. "A Theory of Human Motivation," *Psychological Review*, July 1943, pp. 370-396.
- Mayer, Robert R. "Social System Models for Planners," *Journal of the American Institute of Planners*, May 1972, pp. 130-139.
- McClintock, Charles G., and David M. Messick. "Empirical Approaches to Game Theory and Bargaining: A Bibliography," *General Systems*, 1966, pp. 229-238.
- McDougall, Glen. "The Systems Approach to Planning: A Critique," *Socio-Economic Planning Sciences*, February 1973, pp. 79-90.

- McHarg, Ian L. *Design with Nature*, Doubleday/Natural History Press, New York, 1969, 197 pp.
- McHarg, Ian L., and Michael Clarke, "Skippack Watershed and the Evansburg Project: A Case Study for Water Resources Planning," in *Environmental Quality and Water Development*, Charles R. Goldman, James McEvoy III, and Peter J. Richerson, eds., W. H. Freeman and Company, San Francisco, 1973, pp. 299-330.
- McLaughlin, John James. *A Study of the Social Aspects of Water Resources Management in the Upper St. Johns River Basin*, Master's Thesis, Department of Environmental Engineering Sciences, University of Florida, Gainesville, Florida, 1973, 175 pp.
- McLoughlin, J. Brian. *Urban and Regional Planning: A Systems Approach*, Frederick A. Praeger, Publishers, New York, 1969, 331 pp.
- McLoughlin, J. Brian, and Judith N. Webster. "Cybernetic and General System Approaches to Urban and Regional Research: A Review of the Literature," *Environment and Planning*, Vol. 2, 1970, pp. 369-408.
- McNeil, Elton, ed. *The Nature of Human Conflict*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1965.
- McWhinney, W. H. "Aspiration Levels and Utility Theory," *General Systems*, 1965, pp. 131-143.
- Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William W. Behrens III. *The Limits to Growth*, Universe Books, New York, 1972, 205 pp.
- Meeker, B. F. "Decisions and Exchange," *American Journal of Sociology*, June 1971, pp. 485-495.
- Meyerson, Martin, and Edward C. Banfield. *Politics, Planning and the Public Interest*, The Free Press, New York, 1955, 353 pp.
- Michalos, Alex C. "The Costs of Decision-Making," *Public Choice*, Fall 1970, pp. 39-51.
- Miller, Delbert C. "Power Structure Studies and Environmental Management: The Study of Powerful Urban Problem-Oriented Leaders in Northeastern Megalopolis," in *Environmental Quality Analysis*, Allen V. Kneese and Blair T. Bower, eds., The Johns Hopkins Press, Baltimore, 1972, pp. 345-395.
- Miller, James G. "The Nature of Living Systems," *Behavioral Science*, July 1971, pp. 277-301.
- Miller, James G. "Living Systems: The Organization," *Behavioral Science*, January 1972, pp. 1-182.

- Miller, James R. III. *Assessing Alternative Transportation Systems*, RM-5k65-DOT, The Rand Corporation, Santa Monica, Calif., April 1969, 161 pp.
- Miller, William L., and D. Byers. "Economic Efficiency vs. Environmental Quality in Small Watershed Development," in *Watersheds in Transition*, American Water Resources Association, Urbana, Illinois, 1972, pp. 63-67.
- Miller, W. L., and D. M. Byers. "Development and Display of Multiple-Objective Project Impacts," *Water Resources Research*, February 1973, pp. 11-20.
- Mitchell, William C. *The American Polity*, The Free Press, New York, 1962, 434 pp.
- Mitchell, William. *Sociological Analysis and Politics*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1967, 222 pp.
- Monarchi, David Edward. *An Interactive Algorithm for Multiobjective Decision Making*, Technical Report No. 6, Department of Hydrology and Water Resources, University of Arizona, Tucson, June 1972, 189 pp.
- Monarchi, David E., Chester C. Kisiel, and Lucien Duckstein. "Interactive Multiobjective Programming in Water Resources: A Case Study," *Water Resources Research*, August 1973, pp. 837-850.
- Morris, William T. *Management for Action: Psychotechnical Decision Making*, Reston Publishing Company, Inc., Reston, Virginia, 1972a, 223 pp.
- Morris, William T. "Objectives and Criteria Development," *International Symposium on Systems Engineering and Analysis*, Vol. 1, Purdue University, Lafayette, Indiana, October 1972b, pp. 41-47.
- Mumphrey, Anthony J., Jr., John E. Seley, and Julian Wolpert. "A Decision Model for Locating Controversial Facilities," *Journal of the American Institute of Planners*, November 1971, pp. 397-402.
- Munger, James A., and Jack D. Edwards. "The Splended but Superficial Contribution of Conventional Economic Analysis to the Management of Public Resources," *Annals of Regional Science*, June 1970, pp. 29-37.
- Murray, Edward J. "Conflict: Psychological Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 3, pp. 220-226.
- Nader, Laura. "Conflict: Anthropological Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 3, pp. 236-242.

- (NAS/NRC), National Academy of Sciences--National Research Council. *Alternatives in Water Management*, Publication No. 1408, Washington, D.C., 1966, 52 pp.
- Nelson, Dalmas H., and Eugene C. Price. "Realignment, Readjustment, Reform: The Impact of the Ombudsman on American Constitutional and Political Institutions," *The Annals*, Vol. 377, May 1968, pp. 128-138.
- Nelson, Stephen D. *The Concept of Social Conflict*, Institute of Social Research, The University of Michigan, Ann Arbor, 1971, 104 pp.
- North, Robert C. "Conflict: Political Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 3, pp. 226-232.
- Nuttall, Roland L., Erwin K. Scheuch, and Chad Gordon. "On the Structure of Influence," in *Community Structure and Decision-Making: Comparative Analyses*, Terry N. Clark, ed., Chandler Publishing Company, San Francisco, 1968, pp. 349-380.
- Odum, Howard T. *Environment, Power, and Society*, Wiley-Interscience, New York, 1971, 331 pp.
- Odum, H. T., C. Littlejohn, and W. C. Huber. *An Environmental Evaluation of the Gordon River of Naples, Florida and the Impact of Developmental Plans*, Report to the County Commissioners of Collier County, Florida, Department of Environmental Engineering, University of Florida, Gainesville, September 1972.
- Odum, Howard T., and Richard C. Pinkerton. "Time's Speed Regulator: The Optimum Efficiency for Maximum Power Output in Physical and Biological Systems," *American Scientist*, April 1955, pp. 331-343.
- Ofshe, Lynne, and Richard Ofshe. *Utility and Choice in Social Interaction*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970, 202 pp.
- Ogden, Daniel M., Jr. "The Real World of Political Decision Making in Water Resources Policy," in *Treatise on Urban Water Systems*, Maurice L. Albertson, L. Scott Tucker, and Donald C. Taylor, eds., Colorado State University, Fort Collins, July 1971, pp. 740-752.
- Olsen, Marvin E., ed. *Power in Societies*, The Macmillan Company, New York, 1970, 451pp.
- Olson, Mancur, Jr. *The Logic of Collective Action*, Schocken Books, New York, 1968, 176 pp.
- Ostrom, Vincent. "Water Resources Development: Some Problems in Economic and Political Analysis of Public Policy," in *Political Science and Public Policy*, Austin Ranney, ed., Markham Publishing Company, Chicago, 1968, pp. 123-150.

- Ostrom, Vincent. *Institutional Arrangements for Water Resource Development*, Report No. NWC-SBS-70-034, National Water Commission, Arlington, Virginia, December 1971a, 596 pp.
- Ostrom, Vincent. *The Political Theory of a Compound Republic*, Center for Study of Public Choice, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1971b, 132 pp.
- Ostrom, Vincent. "Some Problems of Institutional Analysis," in *Institutions for Urban-Metropolitan Water Management: Essays in Social Theory*, Norman Wengert, ed., Completion Report Series No. 39, Environmental Resources Center, Colorado State University, Fort Collins, Colorado, November 1972a, pp. 51-63.
- Ostrom, Vincent. Personal Communication, 17 November 1972b.
- Ostrom, Vincent. "Polycentricity," Presented at 1972 Annual Meeting of the American Political Science Association, Washington, D.C., September 1972c, 44 pp.
- Ostrom, Vincent. *The Intellectual Crisis in American Public Administration*, The University of Alabama Press, University, Alabama, 1973, 165 pp.
- Ostrom, Vincent, and Elinor Ostrom. "Public Choice: A Different Approach to the Study of Public Administration," *Public Administration Review*, March/April 1971, pp. 203-216.
- Ostrom, Vincent, and Elinor Ostrom. "Conditions of Legal and Political Feasibility," in *Natural Resource Systems Models in Decision Making*, Gerrit H. Toebe, ed., Water Resources Research Center, Purdue University, Lafayette, Indiana, May 1970, pp. 191-208.
- Ostrom, Vincent, and Elinor Ostrom. "Legal and Political Conditions of Water Resource Development," *Land Economics*, February 1972, pp. 1-14.
- Ozbekhan, Hasan. "The Triumph of Technology: 'Can' Implies 'Ought,'" in *Planning for Diversity and Choice*, Stanford Anderson, ed., The M.I.T. Press, Cambridge, Massachusetts, 1968a, pp. 204-233.
- Ozbekhan, Hasan. "Toward a General Theory of Planning," in *Perspectives of Planning*, Erich Jantsch, ed., Organization for Economic Co-operation and Development (OECD), Washington, D.C., 1968b, pp. 45-155.
- Pardee, F. S., T. F. Kirkwood, K. L. Kraemer, K. R. MacCrimmon, J. R. Miller III, C. T. Phillips, J. W. Ranftl, K. V. Smith, and D. K. Whitcomb. *Measurement and Evaluation of Transportation System Effectiveness*, R.M.-5869-DOT, The Rand Corporation, Santa Monica, Calif., September 1969, 463 pp.

- Park, James R., and Joseph G. Monks. "Objectives of Water Resources Management--Can They Be Achieved Through Legislation?" in *Watersheds in Transition*, Proceedings Series No. 14, American Water Resources Association, Urbana, Illinois, 1972, pp. 32-38.
- Parsons, Talcott. "On the Concept of Influence," *Public Opinion Quarterly*, Spring 1963a, pp. 37-67.
- Parsons, Talcott. "On the Concept of Political Power," *Proceedings of the American Philosophical Society*, June 1963b, pp. 232-262.
- Parsons, Talcott. "The Political Aspect of Social Structure and Process," in *Varieties of Political Theory*, David Easton, ed., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966, pp. 71-112.
- Parsons, Talcott. "Utilitarianism: Sociological Thought," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 12, pp. 229-236.
- Patchen, Martin. "Models of Cooperation and Conflict," *Journal of Conflict Resolution*, September 1970, pp. 389-407.
- Pattanaik, Prasanta K. *Voting and Collective Choice*, Cambridge University Press, New York, 1971, 183 pp.
- Peattie, Lisa R. "Reflections on Advocacy Planning," *Journal of the American Institute of Planners*, March 1968, pp. 80-88.
- Pellegrin, Roland J. "Selected Bibliography on Community Power Structure," *Southwestern Social Science Quarterly*, December 1967, pp. 451-465.
- Peterson, John H., Jr. *Community Organization and Rural Watershed Development*, Water Resources Research Institute, Mississippi State University, State College, 1971, 53 pp.
- Peterson, John H., Jr., and Peggy J. Ross. *Changing Attitudes Toward Watershed Development*, Water Resources Research Institute, Mississippi State University, State College, 1971, 51 pp.
- Pfiffner, John M. "Administrative Rationality," *Public Administration Review*, Summer 1960, pp. 125-132.
- Platt, John. "How Men Can Shape Their Future," *World Future Society Bulletin*, June 1970.
- Polsby, Nelson W. *Community Power and Political Theory*, Yale University Press, New Haven, Connecticut, 1963, 144 pp.
- Polsby, Nelson W. "Community: The Study of Community Power," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 3, pp. 156-163.

- Pool, Ithiel de Sola, Robert P. Abelson, and Samuel L. Popkin. *Candidates, Issues, and Strategies*, The M.I.T. Press, Cambridge, Massachusetts, 1965, 193 pp.
- Pratt, John W., Howard Raiffa, and Robert O. Schlaifer. *Introduction to Statistical Decision Theory*, McGraw-Hill Book Company, Inc., New York, 1965.
- Quade, E. S. "Why Policy Sciences?" *Policy Sciences*, Spring 1970, pp. 1-2.
- Quade, E. S., and W. I. Boucher, eds., *Systems Analysis and Policy Planning: Applications in Defense* (R-439-PR, The Rand Corporation), American Elsevier Publishing Company, Inc., New York, 1968, 453 pp.
- Rae, Douglas W. "Decision-Rules and Individual Values in Constitutional Choice," *American Political Science Review*, March 1969, pp. 40-56.
- Rae, Douglas, and Michael Taylor. "Some Ambiguities in the Concept of Intensity," *Polity*, Spring 1969, pp. 297-308.
- Raiffa, Howard. *Decision Analysis*, Addison-Wesley Publishing Company, Reading, Massachusetts, 1968, 309 pp.
- Raiffa, Howard. *Preferences for Multi-Attributed Alternatives*, RM-5868-DOT/RC, The Rand Corporation, Santa Monica, Calif., April 1969, 108 pp.
- Ramos, Alberto Guerreiro. "Models of Man and Administrative Theory," *Public Administration Review*, May/June 1972, pp. 241-246.
- Ranney, Austin, ed. *Political Science and Public Policy*, Markham Publishing Company, Chicago, 1968, 287 pp.
- Ranney, David C. *Water Quality Management: An Analysis of Institutional Patterns*, The University of Wisconsin Press, Madison, 1972, 158 pp.
- Rapoport, Amnon, and Thomas S. Wallsten. "Individual Decision Behavior," *Annual Review of Psychology*, 1972, pp. 131-176.
- Rapoport, Anatol. "Critiques of Game Theory," *Behavioral Science*, January 1950, pp. 49-66.
- Rapoport, Anatol. *Fights, Games, and Debates*, The University of Michigan Press, Ann Arbor, 1960, 400 pp.
- Rapoport, Anatol. "Three Modes of Conflict," *Management Science*, April 1961, pp. 210-218.

- Rapoport, Anatol. "Mathematical Models of Social Interaction," in *Handbook of Mathematical Psychology*, Vol. 2, R. D. Luce, R. R. Bush, and E. Galanter, eds., John Wiley & Sons, Inc., New York, 1963, pp. 493-580.
- Rapoport, Anatol. *Two-Person Game Theory*, The University of Michigan Press, Ann Arbor, 1966, 229 pp.
- Rapoport, Anatol. "Conflict Resolution in the Light of Game Theory and Beyond," in *The Structure of Conflict*, Paul Swingle, ed., Academic Press, New York, 1970a, pp. 1-43.
- Rapoport, Anatol. *N-Person Game Theory*, The University of Michigan Press, Ann Arbor, 1970b, 331 pp.
- Rapoport, Anatol, and William J. Horvath. "Thoughts on Organization Theory," *General Systems*, 1959, pp. 87-91.
- Raser, John R. *Simulation and Society*, Allyn and Bacon, Inc., Boston, 1969, 180 pp.
- Raven, Bertram H., and Arie W. Kruglanski. "Conflict and Power," in *The Structure of Conflict*, Paul Swingle, ed., Academic Press, New York, 1970, pp. 69-109.
- Rescher, Nicholas. "Delphi and Values," P-4182, The Rand Corporation, Santa Monica, Calif., September 1969a, 19 pp.
- Rescher, Nicholas. *Introduction to Value Theory*, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1969b, 199 pp.
- Ricci, David M. "Methodological Disputes in the Study of Power," in *Political Power, Community, and Democracy*, Edward Keynes and David M. Ricci, eds., Rand McNally & Company, Chicago, 1970, pp. 155-178.
- Richerson, Peter, and James McEvoy III. "The Measurement of Environmental Quality," in *Environmental Quality and Water Development*, Charles R. Goldman, James McEvoy III, and Peter J. Richerson, eds., W. H. Freeman and Company, San Francisco, 1973, pp. 111-134.
- Riker, William H. "A Test of the Adequacy of the Power Index," *Behavioral Science*, 1959, pp. 276-290.
- Riker, William H. "Voting and the Summation of Preferences: An Interpretative Bibliographic Review of Selected Developments During the Last Decade," *American Political Science Review*, December 1961, pp. 900-911.
- Riker, William H. *The Theory of Political Coalitions*, Yale University Press, New Haven, Connecticut, 1962, 300 pp.

- Riker, William H. "The Study of Coalitions," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, New York, 1968, Vol. 2, pp. 524-529.
- Robinson, James A., and R. Roger Majak. "The Theory of Decision-Making," in *Contemporary Political Analysis*, James C. Charlesworth, ed., The Free Press, New York, 1967, pp. 175-188.
- Robinson, James A., and Richard C. Snyder. "Decision-Making in International Politics," in *International Behavior: A Social-Psychological Analysis*, Herbert Kelman, ed., Holt, Rinehart, and Winston, New York, 1965, pp. 435-463.
- Rogers, Everett M. "Communication and Collective Innovation--Decisions," *Journal of the Water Pollution Control Federation*, January 1970, pp. 1-9.
- Rogers, Everett M., and F. Floyd Shoemaker. *Communication of Innovations*, The Free Press, New York, 1971, 476 pp.
- Rogers, Everett M. "Social Structure and Social Change," *American Behavioral Scientist*, May/June 1971, pp. 767-782.
- Rose, Arnold M. *The Power Structure*, Oxford University Press, New York, 1967, 506 pp.
- Rosenau, James N. "The Premises and Promises of Decision-Making Analysis," in *Contemporary Political Analysis*, James C. Charlesworth, ed., The Free Press, New York, 1967, pp. 189-211.
- Rosenberg, Seymour. "Mathematical Models of Social Behavior," in *Handbook of Social Psychology*, Vol. 1, Gardner Lindzey and Elliot Aranson, eds., Addison-Wesley Publishing Company, Reading, Massachusetts, 2nd ed., 1968, pp. 179-244.
- Ross, Robert, and Alan Guskin. *Advocacy and Democracy: Towards a Research Program*, Institute for Social Research, The University of Michigan, Ann Arbor (working paper, no publication details), 28 pp.
- Saaty, Thomas L. "Mathematical Structures Applicable to Multi-Party Conflicts," *Papers, Peace Research Society (International)*, Vol. XVII, 1971, pp. 7-30.
- Salisbury, Robert H. "An Exchange Theory of Interest Groups," *Midwest Journal of Political Science*, February 1969, pp. 1-32.
- Sandler, Ake. "An Ombudsman for the United States," *The Annals*, Vol. 377, May 1968, pp. 104-110.
- Sarbin, Theodore R. "Role: Psychological Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 13, pp. 546-552.

- Sargent, Howard L., Jr. "Fishbowl Planning Immerses Pacific Northwest Citizens in Corps Projects," *Civil Engineering*, September 1972, pp. 54-57.
- Schmid, A. Allan. *Federal Decision-Making for Water Resource Development*, Report No. NWC-SBS-72-051, National Water Commission, Arlington, Virginia, December 1971, 99 pp.
- Schevitz, Jeffrey M. "The Incorporation of Pluralism into Parsons' Theory of the Polity," *American Behavioral Scientist*, November/December 1968, pp. 21-27.
- Schlaifer, Robert O. *Analysis of Decisions Under Uncertainty*, McGraw-Hill Book Company, Inc., New York, 1967.
- Schlesinger, James R. "Systems Analysis and the Political Process," P-3464, The Rand Corporation, Santa Monica, Calif., June 1967, 31 pp.
- Schneider, Jerry B. "The Policy Delphi: A Regional Planning Application," *Technological Forecasting and Social Change*, No. 3, 1972, pp. 481-497.
- Schoeffler, Sidney. "Toward a General Definition of Rational Action," *Kylos*, 2nd Quarter 1954, pp. 245-273.
- Schopler, John. "Social Power," in *Advances in Experimental Social Psychology*, Vol. 2, Leonard Berkowitz, ed., Academic Press, New York, 1965, pp. 177-218.
- Schubert, Glendon. *The Public Interest*, The Free Press, Glencoe, Illinois, 1960, 244 pp.
- Sen, Amartya Kumar. *Collective Choice and Social Welfare*, Holden-Day, Inc., San Francisco, 1970, 225 pp.
- Shaffer, William R. *Computer Simulations of Voting Behavior*, Oxford University Press, New York, 1972, 164 pp.
- Shapiro, David L. "Pressure Groups and Public Investment Decisions: A Note," *Public Choice*, Spring 1971, pp. 103-108.
- Shapley, Lloyd S. "A Value for n-Person Games," in *Contributions to the Theory of Games*, Vol. 2, H. W. Kuhn and A. W. Tucker, eds., Princeton University Press, Princeton, New Jersey, 1953, pp. 307-317.
- Snapley, L. S., and Martin Shubik. "A Method for Evaluating the Distribution of Power in a Committee System," *American Political Science Review*, September 1954, pp. 787-792.

- Shaw, Marvin E. *Group Dynamics*, McGraw-Hill Book Company, New York, 1971, 414 pp.
- Sheaffer, John R., George W. Davis, and Alan P. Richmond. *Community Goals--Management Opportunities: An Approach to Flood Plain Management*, IWR Report 70-2, Institute for Water Resources, Alexandria, Virginia, May 1970, 235 pp.
- Shelly, Maynard W. II, and Glenn L. Bryan, eds. *Human Judgements and Optimality*, John Wiley & Sons, Inc., New York, 1964, 436 pp.
- Shepard, R. N. "On Subjectively Optimum Selections Among Multi-attribute Alternatives," in *Human Judgement and Optimality*, M. W. Shelly and G. L. Bryan eds., John Wiley & Sons, Inc., New York, 1964, pp. 257-281.
- Shepard, Roger N., A. Kimball Romney, and Sara Beth Nerlove, eds. *Multidimensional Scaling: Volume I, Theory*, Seminar Press, New York, 1972, 261 pp.
- Shils, Edward. "The Concept of Consensus," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company, 1968, Vol. 3, pp. 260-266.
- Shubik, Martin, ed. *Game Theory and Related Approaches to Social Behavior*, John Wiley & Sons, Inc., New York, 1964, 390 pp.
- Siegel, Sidney. "Level of Aspiration and Decision Making," *Psychological Review*, July 1957, pp. 253-262.
- Siegel, Sidney, and Lawrence E. Fouraker. *Bargaining and Group Decision Making*, McGraw-Hill Book Company, Inc., New York, 1960, 132 pp.
- Simon, Herbert A. "A Behaviroal Model of Rational Choice," *Quarterly Journal of Economics*, February 1955, pp. 99-118.
- Simon, Herbert A. *Administrative Behavior*, The Free Press, New York, 2nd ed., 1957a, 259 pp.
- Simon, Herbert A. *Models and Man*, John Wiley & Sons, Inc., New York, 1957b, 287 pp.
- Simon, Herbert A. "Theories of Decision-Making in Economics and Behavioral Science," *American Economic Review*, June 1959, pp. 253-283.
- Simon, Herbert A., and Allen Newell. "Heuristic Problem Solving: The Next Advance in Operations Research," *Operations Research*, January/February 1958, pp. 1-10.

- Snyder, Richard C. "A Decision-Making Approach to the Study of Political Phenomena," in *Approaches to the Study of Politics*, Roland Young, ed., Northwestern University Press, Evanston, Illinois, 1958, pp. 3-38.
- Soil Conservation Service. *Land Resource Regions and Major Land Resource Areas of the United States*, Agricultural Handbook 296, U. S. Department of Agriculture, Washington, D. C., December 1965.
- Sollie, Carlton R. "A Comparison of Reputational Techniques for Identifying Community Leaders," *Rural Sociology*, September 1966, pp. 301-309.
- Spier, Leo. "A Suggested Behavioral Approach to Cost-Benefit Analysis," *Management Science*, June 1971, pp. B672-B693.
- Spilerman, Seymour. "Structural Analysis and the Generation of Sociograms," *Behavioral Science*, July 1966, pp. 312-318.
- Starbuck, William H. "Level of Aspiration Theory and Economic Behavior," *Behavioral Science*, April 1963, pp. 128-136.
- Starbuck, William H. "The Aspiration Mechanism," *General Systems*, 1964, pp. 191-203.
- Steiner, Peter O. "The Public Sector and the Public Interest," in *Public Expenditures and Policy Analysis*, Robert H. Haveman and Julius Margolis, eds., Markham Publishing Company, Chicago, 1971, pp. 21-58.
- Steinitz, Carl, Timothy Murray, David Sinton, and Douglas Way. *A Comparative Study of Resource Analysis Methods*, Department of Landscape Architecture, Harvard University, Cambridge, Massachusetts, July 1969, 382 pp.
- Stevens, Carl M. *Strategy and Collective Bargaining Negotiations*, McGraw-Hill Book Company, Inc., New York, 1963, 192 pp.
- Stevens, S. S. "On the Theory of Scales of Measurement," *Science*, 7 June 1946, pp. 677-680.
- Stevens, S. S., ed. "Mathematics, Measurement, and Psychophysics," in *Handbook of Experimental Psychology*, John Wiley & Sons, Inc., New York, 1966, pp. 1-49.
- Stuart, Darwin G. "Rational Urban Planning: Problems and Prospects," *Urban Affairs Quarterly*, December 1969, pp. 151-182.
- Swingle, Paul, ed. *The Structure of Conflict*, Academic Press, New York, 1970, 305 pp.

- Taylor, Howard F. *Balance in Small Groups*, Van Nostrand, Reinhold Company, New York, 1970, 321 pp.
- Taylor, Michael. "The Problem of Salience in the Theory of Collective Decision-Making," *Behavioral Science*, September 1970, pp. 415-430.
- The Technical Committee of the Water Resources Centers of the Thirteen Western States. *Water Resources Planning and Social Goals: Conceptualization Toward a New Methodology*, Publication PRWG-94-1, Utah Water Research Laboratory, Utah State University, Logan, 1 September 1971, 89 pp.
- Terleckyj, Nestor E. "Measuring Progress Towards Social Goals: Some Possibilities on National and Local Levels," *Management Science*, August 1970, pp. B765-B778.
- Thompson, James D., ed. *Approaches to Organizational Design*, University of Pittsburgh Press, Pittsburgh, 1966, 223 pp.
- Thompson, Peter. "Brandywine Basin: Defeat of an Almost Perfect Plan," *Science*, 14 March 1969, pp. 1180-1182.
- Thompson, Thomas W., Allen E. Bedrosian, James E. Berry, and James W. Kolka. "Biophysical Environment and Human Behavior: Linkages and Feedback Systems," in *Environmental Quality and Social Responsibility*, Ravindra S. Khare, James W. Kolka, and Carol A. Pollis, eds., University of Wisconsin, Green Bay, 1972, pp. 53-57.
- Thuesen, Gerald J. *A Study of Public Attitudes and Multiple Objective Decision Criteria for Water Pollution Control Projects*, Environmental Resources Center, Georgia Institute of Technology, Atlanta, June 1971, 71 pp.
- Tichy, Noel. "An Analysis of Clique Formation and Structure in Organizations," *Administrative Science Quarterly*, June 1973, pp. 194-208.
- Torgerson, Warren S. *Theory and Methods of Scaling*, John Wiley & Sons, Inc., New York, 1958, 460 pp.
- Tukey, John W. "Conclusions vs. Decisions," *Technometrics*, November 1960, pp. 423-433.
- Tullock, Gordon. "Problems of Majority Voting," *Journal of Political Economy*, 1959, pp. 571-579.
- Tullock, Gordon. *Toward a Mathematics of Politics*, The University of Michigan Press, Ann Arbor, 1967, 176 pp.
- Tullock, Gordon. "A Simple Algebraic Logrolling Model," *American Economic Review*, June 1970, pp. 419-426.

- Turner, Ralph H. "Role: Sociological Aspects," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, 1968, New York, Vol. 13, pp. 552-557.
- Turoff, Murray. "The Design of a Policy Delphi," in *National Goals Symposium*, Serial No. 92-11, U.S. Senate, Committee on Interior and Insular Affairs, 22nd Congress, 1st Session, Washington, D.C., 20 October 1971, Part 2, pp. 763-793.
- Universities Council on Water Resources, *Evaluation Processes in Water Resources Management and Development*, Office of Water Resources Research, Washington, D.C., 1971, 42 pp.
- Urban Systems Research & Engineering, Inc. *Metropolitan Water Management: Case Studies and National Policy Implications*, Report NWC-EES-71-002, National Water Commission, Arlington, Virginia, June 1971, 435 pp.
- Urmson, J. O. "Utilitarianism: The Philosophy," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 12, pp. 224-236.
- U.S. Bureau of the Budget. *Circular A-47*, Washington, D.C., 31 December 1952.
- U.S. Congress, Joint Economic Committee. *The Analysis and Evaluation of Public Expenditures: The PPB System*, Vols. 1, 2, and 3, A Compendium of Papers Submitted to the Subcommittee on Economy in Government, 91st Congress, 1st Session, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1969.
- U.S. Corps of Engineers. *General Design Memorandum, Upper St. Johns River Basin*, Office of the District Engineer, Jacksonville, Florida, 20 March 1957.
- U.S. Corps of Engineers. "Revised Plan of Improvement," *Addendum I to General Design Memorandum, Upper St. Johns River Basin*, Office of the District Engineer, Jacksonville, Florida, 15 February 1962.
- U.S. Corps of Engineers. "Modified Plan of Improvement for South Portion," *Addendum II to General Design Memorandum, Upper St. Johns River Basin*, Office of the District Engineer, Jacksonville, Florida, 17 March 1969.
- U.S. Department of Agriculture. *St. Johns River Basin and Intervening Coastal Areas*, Soil Conservation Service, Gainesville, Florida, 1969.

- U.S. Department of Health, Education, and Welfare. *Toward a Social Report*, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., January 1969, 101 pp.
- U.S. Interagency Committee on Water Resources, Subcommittee on Evaluation Standards. *Proposed Practices for Economic Analysis of River Basin Projects*, U.S. Government Printing Office, Washington, D.C., May 1950 (Revised May 1958), 56 pp.
- U.S. Senate. "Reviews of National Water Resources During the Past Fifty Years," Committee Print No. 2, in *Water Resources Activities in the United States*, Select Committee on National Water Resources, 86th Congress, 1st Session, Washington, D.C., October 1959, 44 pp.
- U.S. Senate. *Report of the Select Committee on National Water Resources*, Senate Report No. 29, 87th Congress, 1st Session, Washington, D.C., 1961.
- U.S. Senate. *Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for the Use and Development of Water and Related Land Resources*, Senate Document No. 97, 87th Congress, 2nd Session, 1962, 13 pp.
- U.S. Water Resources Council. *A Summary Analysis of Nineteen Tests of Proposed Evaluation Procedures on Selected Water and Land Resource Projects*, Washington, D.C., July 1970.
- U.S. Water Resources Council. "Proposed Principles and Standards for Planning Water and Related Land Resources," *Federal Register*, Vol. 36, No. 245, Part II, Tuesday 21 December 1971, pp. 24144-24194.
- Verba, Sidney. "Democratic Participation," *The Annals*, Vol. 373, September 1967, pp. 53-78.
- Vickrey, William. "Utility, Strategy, and Social Decision Rules," *Quarterly Journal of Economics*, November 1960, pp. 507-535.
- Vlachos, Evan C. "Social Processes in Water Management Systems," in *Treatise on Urban Water Systems*, Maurice L. Albertson, L. Scott Tucker, and Donald C. Taylor, eds., Colorado State University, Fort Collins, July 1971, pp. 722-739.
- von Bertalanffy, Ludwig. *General Systems Theory*, George Braziller, New York, 1968, 289 pp.
- von Neumann, John, and Oskar Morganstern. *Theory of Games and Economic Behavior*, Princeton University Press, Princeton, New Jersey, 2nd ed., 1947.

- Wade, Larry L., and Robert L. Curry, Jr. "An Economic Model of Socio-Political Bargaining," *American Journal of Economics and Sociology*, October 1971, pp. 383-394.
- Walton, Richard E., and Robert B. McKersie. *Behavioral Theory of Labor Negotiations*, McGraw-Hill, Inc., New York, 1965, 437 pp.
- Walton, Richard E., and Robert B. McKersie. "Behavioral Dilemmas in Mixed-Motive Decision Making," *Behavioral Science*, September 1966, pp. 370-384.
- Ward, Benjamin. "Majority Rule and Allocation," *Journal of Conflict Resolution*, October 1961, pp. 379-389.
- Warfield, John N., and J. Douglas Hiu. *A Unified Systems Engineering Concept*, Monograph No. 1, Battelle Memorial Institute, Columbus, Ohio, June 1972, 86 pp.
- Warner, Katharine P. *A State of the Arts Study of Public Participation in the Water Resource Planning Process*, Report No. NWC-SBS-71-013, National Water Commission, Arlington, Virginia, July 1971, 235 pp.
- Webber, Melvin M. "The Roles of Intelligence Systems in Urban-Systems Planning," *Journal of the American Institute of Planners*, November 1965, pp. 289-296.
- Weinwurm, Ernest H. "Limitations of the Scientific Method in Management Science," *Management Science*, April 1957, pp. 225-233.
- Wengert, Norman. "Public Participation in Water Planning: A Critique of Theory, Doctrine, and Practice," *Water Resources Bulletin*, February 1971a, pp. 26-32.
- Wengert, Norman. "Political and Social Accommodation: The Political Process and Environmental Preservation," *Natural Resources Journal*, July 1971, pp. 437-446.
- Wengert, Norman. *Urban-Metropolitan Institutions for Water Planning, Development and Management: An Analysis of Usages of the Term "Institutions,"* Completion Report Series No. 36, Environmental Resources Center, Colorado State University, Fort Collins, September 1972a, 88 pp.
- Wengert, Norman, ed. *Institutions for Urban-Metropolitan Water Management: Essays in Social Theory*, Completion Report Series No. 39, Environmental Resources Center, Colorado State University, Fort Collins, Colorado, November 1972b, 93 pp.

- Wengert, Norman. "Where Can We Go With Public Participation in the Planning Process?" in *Social and Economic Aspects of Water Resources Development*, Leonard B. Dworsky, David J. Allee, and Sandor C. Csallany, eds., Proceedings Series No. 12, American Water Resources Association, Urbana, Illinois, 1972c, pp. 9-18.
- Wengert, Norman. "What Do We Mean by 'Metropolitan Water Management Institutions'?" *Water Resources Bulletin*, June 1973, pp. 512-521.
- Whipple, William, Jr., Ernest A. Engelbert, and Warren L. Trock, eds. *Evaluation Processes in Water Resources Planning*, Proceedings Series No. 10, American Water Resources Association, Urbana, Illinois, June 1970, 156 pp.
- White, Gilbert F. *Choice of Adjustment to Floods*, Research Paper No. 93, Department of Geography, University of Chicago, Chicago, 1964, 150 pp.
- White, Gilbert F. "Formation and Role of Public Attitudes," in *Environmental Quality in a Growing Economy*, Henry Jarrett, ed., The Johns Hopkins Press, Baltimore, 1966, pp. 105-127.
- Wildavsky, Aaron. "The Political Economy of Efficiency: Cost-Benefit Analysis, Systems Analysis, and Program Budgeting," *Public Administration Review*, December 1966, pp. 292-310.
- Wildavsky, Aaron. "The Political Economy of Efficiency," *The Public Interest*, Summer 1967, pp. 30-48.
- Wildavsky, Aaron. "Rescuing Policy Analysis from PPBS," in *Public Expenditures and Policy Analysis*, Robert H. Haveman and Julius Margolis, eds., Markham Publishing Company, Chicago, 1970, pp. 461-481.
- Wilkinson, Kenneth P. *Local Action and Acceptance of Watershed Development*, Water Resources Research Institute, Mississippi State University, State College, July 1966, 43 pp.
- Wilkinson, Kenneth P. "Diffusion of Technology and Political Information: What Theory Do We Have?" in *Social and Economic Aspects of Water Resources Development*, Leonard B. Dworsky, David J. Allee, and Sandor C. Csallany, eds., Proceedings Series No. 12, American Water Resources Association, Urbana, Illinois, 1972, pp. 2-6.
- Wilkinson, Kenneth P., and R. N. Singh. *Community Leadership and Watershed Development*, Water Resources Research Institute, Mississippi State University, State College, 1970, 62 pp.
- Williams, Robin M., Jr. "Individual and Group Values," *The Annals*, Vol. 371, May 1967, pp. 20-37.

- Williams, Robin M., Jr. "Values," in *International Encyclopedia of the Social Sciences*, David L. Sills, ed., The Macmillan Company and The Free Press, New York, 1968, Vol. 16, pp. 283-287.
- Wilson, Ian H. *Our Future Business Environment: A Re-Evaluation*, ERM 85-B, Business Environment Working Paper, General Electric Company, New York, July 1969, 43 pp.
- Wilson, Ian H. "How Our Values Are Changing," *The Futurist*, February 1970, pp. 5-9.
- Wilson, Ian H. "The New Reformation: Changing Values and Institutional Goals," *The Futurist*, June 1971, pp. 105-108.
- Wilson, Raymond H. *Toward A Philosophy of Planning: Attitudes of Federal Water Planners*, EPA-R5-73-015, Socio-Economic Environmental Studies Series, U.S. Environmental Protection Agency, Washington, D.C., March 1973, 224 pp.
- Wilson, Robert W. "An Axiomatic Model of Logrolling," *American Economic Review*, June 1969, pp. 331-341.
- (WRSIC), Water Resources Scientific Information Center. *Institutional Aspects of Water Resources Development: A Bibliography*, Office of Water Resources Research, U.S. Department of the Interior, Washington, D.C., September 1971, 287 pp.
- (WRSIC), Water Resources Scientific Information Center. *Urban Water Planning: A Bibliography*, George F. Mangan and Herbert A. Swenson, eds., Office of Water Resources Research, U.S. Department of the Interior, Washington, D.C., July 1972, 373 pp.
- Young, Oran R. *Systems of Political Science*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968, 113 pp.
- Young, Robert C. "Goals and Goal-Setting," *Journal of the American Institute of Planners*, March 1966, pp. 76-85.
- York, C. Michael, and Glen D. Baskett. *A Citizen Panel for Atlanta Area Studies: Field Experimentation and Methodological Substudies*, Environmental Resources Center, Georgia Institute of Technology, Atlanta, June 1971, 64 pp.
- Zinnes, Joseph L. "Scaling," *Annual Review of Psychology*, 1969, pp. 447-478.

BIOGRAPHICAL SKETCH

On July 11, 1942, I was born in Culpeper, Virginia, to Roy C., Jr., and Frances J. Burke. We moved shortly thereafter to Alexandria, Virginia, where for the next three years my father worked in a defense plant near Washington, D. C. After the war, in 1945, our family, including one older brother, moved back to Culpeper County, this time settling in a small community called Brandy Station (site of the largest cavalry battle in the War Between the States).

In 1948, I entered the local elementary school and spent the next seven years in this small, 4-room picturesque, rural schoolhouse. Following these years, in 1955, I entered the consolidated Culpeper County High School and graduated in June 1960 with a college preparatory major and all the enlightenment which the 1950s can give anyone. Then, without very good reason, I enrolled in the civil engineering department at the University of Virginia, and with financial aid from scholarship funds, part-time work, and ROTC, graduated in June 1965. While in Charlottesville, I achieved the Dean's List and Phi Eta Sigma and participated in Engineering Student Council, Jefferson Sabres (ROTC honorary), Theta Tau, ASCE, and the Pi Kappa Alpha social fraternity.

This civil engineering degree only opened up various career doors and, to me, did not represent a satisfactory stopping point. Thus, I next enrolled in the University of Florida (September 1965)

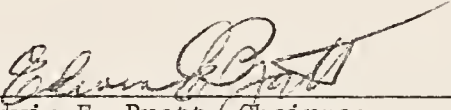
to study sanitary engineering in the Master of Engineering program provided by the department of civil engineering. With financial support from the Public Health Service traineeship program, I successfully completed the Master's requirements and graduated in August 1966 with a major in water pollution control and a minor in chemistry.

Because of ROTC commitments, I entered active duty as a Second Lieutenant, Medical Service Corps, at Fort Sam Houston, Texas, in December 1966. After four months of schooling in MSC officer basic requirements and sanitary engineering, I was assigned permanently to the Air Pollution Engineering Division, U. S. Army Environmental Hygiene Agency, Edgewood Arsenal, Maryland. For the remainder of this tour of duty, I performed air pollution inventories and supervised air pollution sampling surveys at U. S. Army installations and contracted manufacturing plants. During this period (October 1967), I was promoted to Captain and then finally discharged in December 1968.

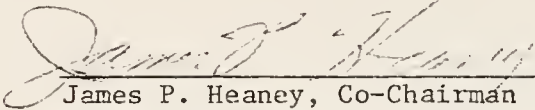
The twenty months' experience at USAEHA-APED only revealed numerous, frustrating weaknesses in my background; thus, I re-entered the University of Florida in April 1969 to pursue a Ph.D. in the department of bioenvironmental engineering. Five years later, and after two departmental title changes, I have arrived at this point of submitting a completed dissertation. It represents a blending of many ideas from various fields and evolved slowly over the course of my Ph.D. program. Hopefully, the years and sweat can be detected in the character of this final thesis. Also, in the course of events, I have collected memberships in the following professional organizations: American Society

of Civil Engineers, American Water Works Association, Water Pollution Control Federation, Air Pollution Control Association, American Water Resources Association, American Geophysical Union, International Water Resources Association, Public Choice Society, Federation of American Scientists, and World Future Society.

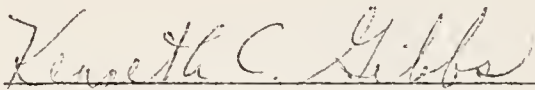
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Edwin E. Pyatt, Chairman
Professor of Environmental
Engineering Sciences

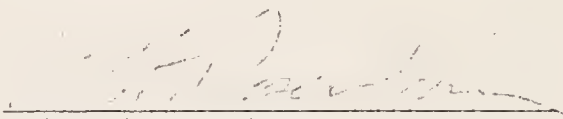
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


James P. Heaney, Co-Chairman
Associate Professor of Environ-
mental Engineering Sciences

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Kenneth C. Gibbs
Assistant Professor of Food and
Resource Economics

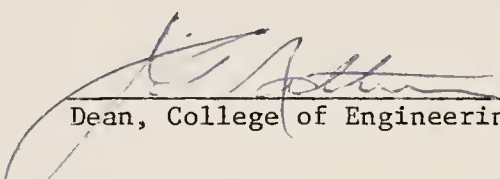
I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


Walter A. Rosenbaum
Associate Professor of Political
Science

This dissertation was submitted to the Graduate Faculty of the College of Engineering and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

;

June, 1974



Dean, College of Engineering

Dean, Graduate School



UNIVERSITY OF FLORIDA



3 1262 08553 9335